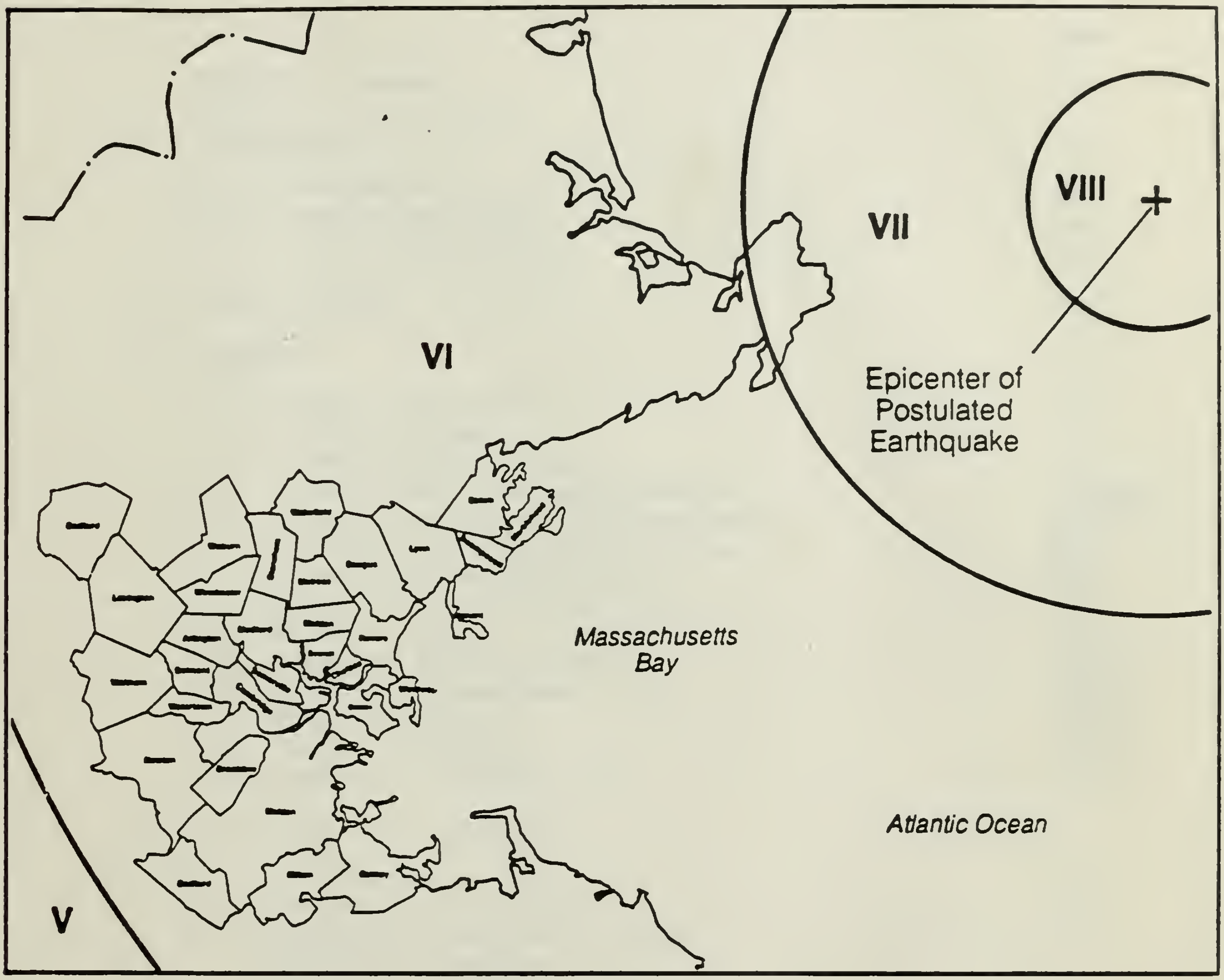
Metropolitan Boston Area Earthquake Loss Study



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1. INTRODUCTION

1.1 Background

In the public consciousness, risk of widespread damage and loss of life due to earthquakes are seen as problems unique to California or perhaps to the West Coast. However, this perception is beginning to change as a result of the work of researchers in geology, seismotectonics, and earthquake engineering, as well as the efforts of public agencies, such as the United States Geological Survey and the Federal Emergency Management Agency. An increasing number of public figures and planning and regulatory officials are becoming aware that, while the earthquake risk on the West Coast is perhaps more immediate and acute, other regions of the country are not immune to earthquake hazards. Increasing attention and funds are being directed toward a better understanding of the seismicity of these regions, the earthquake-resistant characteristics (or lack thereof) of their building stock and lifelines, and the potential consequences of a damaging earthquake to their economies and public safety.

One such region, Massachusetts, is considered to have a moderate earthquake hazard. It has one of the longest histories of reported earthquake activity in the country, dating back to stories of earthquakes that the early settlers learned from the native Indians. The following summary is from John E. Ebel. [1]

> The Plymouth Pilgrims themselves felt their first earthquake in 1638, only eighteen years after their arrival in New England. That first shock rattled dishes, doors and buildings and was plainly felt by those outdoors. The shaking so frightened some of those working in the fields that they cast down their tools and ran panic-stricken through the countryside. As the population grew and the New England wilderness became settled, the number of reports of earthquakes also increased. Most of these accounts were about mild tremors or shocks which were felt in only a few localities and caused no damage. However, some

> of the events were associated with stronger shaking and some even struck with a frightening violence. From the time that the first earthquake was felt in 1638, no more than a few years has passed before someone in New England has felt an earthquake.
>
> Many earthquakes have left their marks on the region in one way or another. The earthquake of 1663, which was probably centered near the confluence of the La Malbaie and St. Lawrence Rivers northeast of Quebec City in Canada, was felt quite strongly over New England. In 1727 a temblor rattled the east coast from Maine to Delaware. The shock was centered near the town of Newbury, Massachusetts at the mouth of the Merrimac River. The shaking from that earthquake leveled many chimneys in the town, caused stone walls to fall, and collapsed some cellar walls. Needless to say, the populace of the area was badly frightened by the earthquake, and preachers took the opportunity to chastise their congregations for the sins which had brought on such a calamity. An even stronger shock rocked eastern Massachusetts in 1755. This earthquake was felt from Halifax, Nova Scotia to Chesapeake Bay in Maryland from Lake George, New York to a ship located 200 miles east of Cape Ann. The greatest damage from this temblor occurred from Cape Ann to Boston, where chimneys were shattered and objects were flung from shelves. A vane atop Fanieul Hall which was supported by a five inch wooden shaft was broken off by the quake. Some streets in Boston were so cluttered by the remnants of fallen chimneys that they were rendered all but impassible.
>
> Surviving accounts of this shock are typical of those from large earthquakes. The shaking was accompanied by a loud roaring sound which seemed to grow stronger during the passage of the earthquake waves. Some persons reported having trouble standing during the height of the concussions....
>
> More recent earthquakes of particular note include a major earthquake centered in the La Malbaie, Quebec, vicinity in 1925 which was felt as far south as Virginia, a pair of damaging earthquakes near Ossippe, New Hampshire in 1940 which were felt all over New England, and an earthquake of strong intensity which struck the Cornwall, Ontario and Massena, New York in 1944.

The 1727 and 1755 earthquakes off the coast of Cape Ann are the dominant events in the historical record of the seismicity of New

England and, perhaps more than any other events, have served to classify eastern Massachusetts as an area of moderate seismic hazard.

The continuing seismic activity in New England, and the fact that most of the building stock and the lifelines in metropolitan Boston were constructed prior to the adoption of seismic provisions in the *Massachusetts State Building Code* in 1975, prompted the Massachusetts Civil Defense Agency and Office of Emergency Preparedness (MCDA) to initiate an earthquake hazard mitigation program with funding from the Federal Emergency Management Agency (FEMA).

> The initial task was to convene an advisory committee of prominent engineers, architects, seismologists, geologists and earthquake scientists from such institutions and corporations as Harvard University, Massachusetts Institute of Technology (MIT), Boston College and Weston Geophysical Research, Inc. The committee, chaired by Dr. M. Nafi Toksoz of MIT, was commissioned with the task of undertaking a New England earthquake risk analysis study with a special focus on Massachusetts. After numerous meetings and months of intensive work, the committee issued its report titled, *The Seismicity of New England and the Earthquake Hazard in Massachusetts*. The committee's findings supported the earlier contention that Massachusetts and New England are regions of moderate earthquake hazard. They went on to recommend that a full earthquake loss analysis study be undertaken for the Metropolitan Boston area. The committee recommended that the project earthquake be equivalent in magnitude to the November 18, 1755 Cape Ann event. [2]

The second task in the Massachusetts project was to identify the influence of surface soils in the Boston area on earthquake damage. It is commonly accepted by earthquake experts that deep deposits of loose sands or soft clays may significantly amplify earthquake shaking arriving from the source of the earthquake through bedrock. [3] The consequences of this amplification are exhibited in all major earthquakes by substantially higher damage reported in the areas with poor soils. The reports from the 1755 Cape Ann earthquake clearly document higher damage in the fill areas of Boston Harbor, where poor

soils abound. The map of the areas with severe damage from the 1906 San Francisco earthquake almost coincides with the map of areas with poor soils along San Francisco Bay. More recently, the September 1985 Mexico City earthquake is an extreme example in which bedrock motions from a distant earthquake, which would not have been expected to produce more than minor building damage, were amplified by the deep soft clays underlying Mexico City to the extent that hundreds of buildings collapsed and more than 10,000 people were killed.

The Boston area is known to have a widely variable surficial geology, ranging from shallow stiff soils to deep soft clays and loose sands. Thus, the geotechnical firm of Haley and Aldrich, Inc., of Boston was employed to develop maps of the various soil profiles in the metropolitan Boston area to aid in identifying the effects of local soil conditions on earthquake risk. These maps were based on available data and the extensive experience of the firm in Boston.

The third task in the Massachusetts project, reported herein, is the Metropolitan Boston Are Earthquake Loss Study. The metropolitan Boston area was chosen as the study area because of its proximity to the Cape Ann source area, the large areas of filled land (which can increase the shaking intensity), the high population density, and the character of the building stock, which includes many unreinforced masonry buildings dating back to the 19th and early 20th centuries.

1.2 Scope of the Study

The earthquake loss study reported here is for the metropolitan Boston area, which includes the city of Boston and the 30 surrounding cities given in Table 1.1. The purpose of the study is to estimate economic damage, loss of functionality of critical facilities, and casualties resulting from a recurrence of the 1755 Cape Ann earthquake (magnitude 6.25). Special emphasis has been placed on critical facilities, including medical facilities, transportation, utilities,

TABLE 1.1

CITIES INCLUDED IN THE METROPOLITAN

BOSTON EARTHQUAKE LOSS STUDY

City	Area* (sq miles)	Population* (1986)
Arlington	5.2	44,350
Bedford	13.7	12,490
Belmont	4.6	25,020
Boston	43.7	573,600
Brookline	6.6	52,360
Cambridge	6.3	91,260
Chelsea	1.9	25,640
Dedham	10.5	23,810
Everett	3.4	36,330
Lexington	16.5	28,610
Lynn	10.5	78,560
Malden	5.1	53,490
Marblehead	4.4	19,580
Medford	8.2	56,830
Melrose	4.7	28,790
Milton	13.1	25,500
Nahant	1.0	3,940
Newton	17.9	82,140
Quincy	16.5	82,630
Revere	6.0	43,510
Salem	8.0	38,050
Saugus	10.6	25,860
Somerville	3.9	72,280
Stoneham	6.0	22,550
Swampscott	3.1	13,330
Wakefield	7.4	25,170
Waltham	12.4	57,090
Watertown	4.1	32,890
Winchester	5.9	20,120
Winthrop	1.6	18,640
Woburn	12.9	37,380
TOTAL	275.7	1,751,800

* Source: Massachusetts Department of Revenue

communications, residential buildings, dams, emergency public facilities, hazardous material sites, schools, high-rise buildings, and critical industries. The purpose of the study is to provide the foundation for later development of state and local earthquake disaster plans and strategies. As such, the loss study is concerned with areawide losses to large numbers of buildings and facilities. The loss estimates, while intended to provide a realistic assessment of the consequences of the postulated earthquake to metropolitan Boston, are not applicable to individual sites or facilities. Site-specific earthquake loss studies for individual facilities require a more detailed engineering examination of the site and the buildings considered.

1.3 Methodology Overview

Earthquake loss studies can be broadly categorized as site-specific studies, which estimate the loss to one or a relatively few structures, or areawide studies, which estimate the loss to a very large population of structures over a wide area.

Site-specific loss studies typically involve more rigorous analytical techniques than areawide studies because the limited number of structures to be studied allows for more detailed geologic, seismologic, and structural evaluations. The emphasis in areawide studies is on the use of sampling techniques, expert opinion, previous earthquake damage data, and statistical and probabilistic methods. Although areawide and site-specific studies differ widely in the details involved, they have at least five components of their methodologies in common. These are: the seismic hazard, a classification system, an inventory, structure fragilities, and an earthquake loss model.

Figure 1.1 shows a flowchart of how these various components of the loss study methodology are combined to estimate damage, loss of functionality, and casualties. The methodology begins with a given seis-

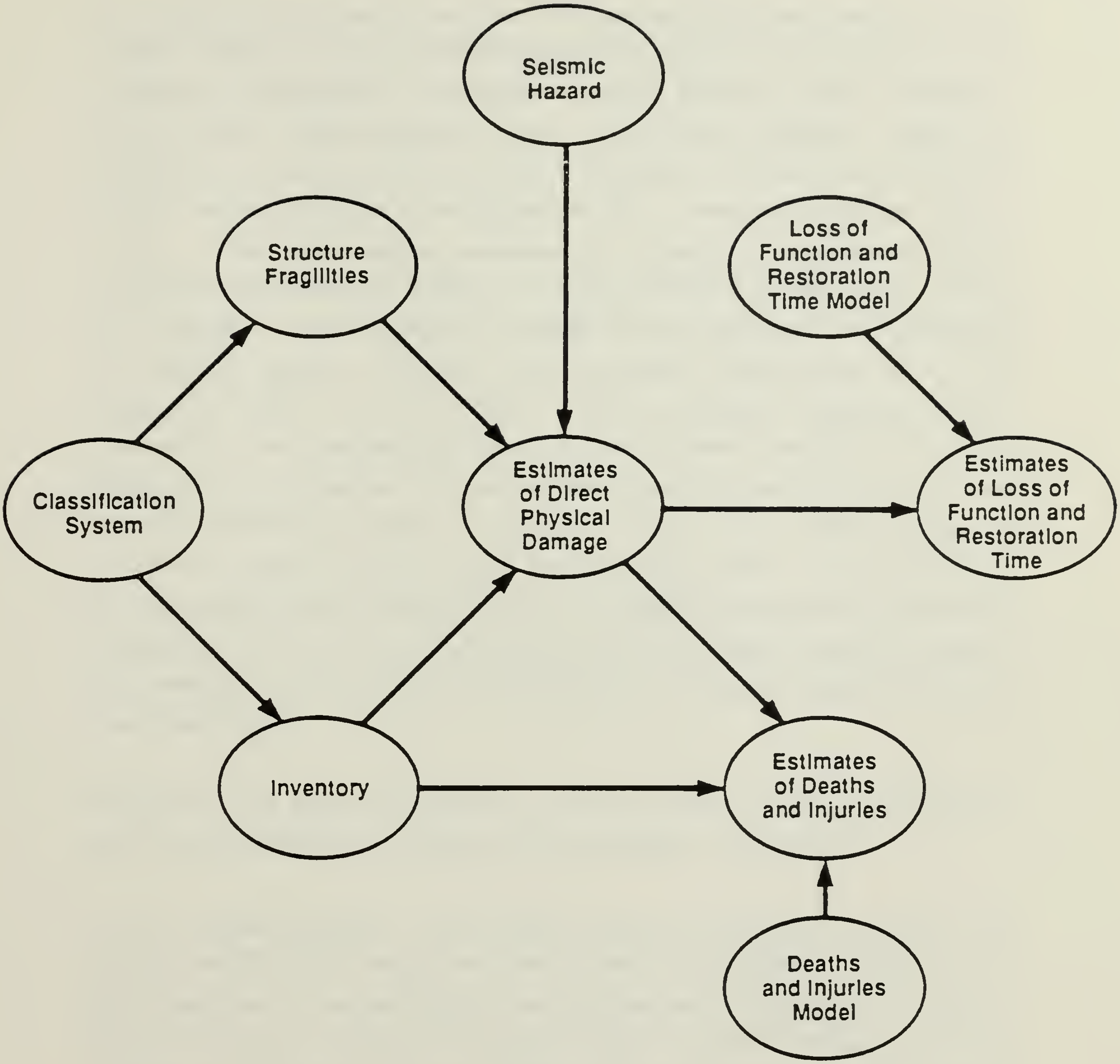


FIGURE 1.1 Flowchart of Earthquake Loss Estimation Methodology

mic hazard, which describes the shaking intensity postulated for the study. The next major component of the study is an inventory that identifies the number of structures, their location, their engineering system characteristics (e.g., low-rise masonry, multispan bridge), and the service that each facility performs in accordance with a social function classification (e.g., medical facility, industrial). The third major component is structure fragilities, which estimate the extent of damage to a given structural type due to seismic shaking. Direct physical damage can be estimated by combining the seismic hazard, inventory, and structure fragilities in a loss estimation model. The estimate of direct physical damage is also central to the methodology used for this study because it is the basis for the estimates of loss of functionality and casualties. The extent of physical damage to a structure type (e.g., severe damage to a low-rise brick building) and the occupancy level can be used to estimate deaths and injuries. Loss of function can also be estimated through the use of loss-of-function matrices, which correlate physical damage to a facility with the degree of loss of functionality of that facility.

Following is a brief discussion of each of these components and their use in the Metropolitan Boston Area Earthquake Loss Study.

1.3.1 Seismic Hazard. The seismic hazard identifies the level of ground shaking for which the loss study is performed. There is a wide spectrum of methodologies and approaches to define the seismic hazard, and the particular approach used is often dictated by the objectives of the loss study. The most common approach for areawide earthquake loss studies is to use a seismic intensity scale. Seismic intensity scales, such as the Modified Mercalli Intensity (MMI) Scale, provide a simple approximate relationship between the severity of seismic shaking and damage to structures.

In this approach, an earthquake with a given magnitude and epicentral location is identified for the study, and appropriate attenuation relationships are utilized to establish the MMI for the study area. These intensities may or may not be increased to account for the effects of poor soil, such as liquefaction, or the amplification of ground shaking severity at a specific site.

This study postulates a recurrence of the 1755 magnitude 6.25 Cape Ann earthquake. An attenuation equation based on the report of the Seismic Risk Analysis Subcommittee [2] is then used to establish the MMI for average soils in the study area. Maps of distribution of soil types in the study area prepared by Haley and Aldrich, Inc., are used to modify these MMI values to account for the effects of soil on earthquake shaking.

1.3.2 Facility Classification. Urban communities contain a great variety of structures serving their economic and social needs. The existing structures would have been designed and constructed over scores of decades using different construction materials and techniques, different codes, and different structural systems. Furthermore, structures with similar structural systems and construction might serve different needs and have different occupancy densities.

Even though each structure's response to an earthquake is unique, an areawide earthquake loss study requires that structures be grouped into broad classes whose overall response is expected to be similar. The engineering characteristics most significant in determining possible earthquake damage are construction material, load-resisting system, age, and size.

Seismic loss studies, which also seek to estimate loss of functionality of critical facilities and restoration time, need another type of classification, often referred to as social function classification. Social function classifications distinguish the use of a

building or structure in connection with the social fabric (e.g., office building, residence, hospital). Thus, structures are categorized by their engineering structure classification (e.g., high-rise steel structures or medium-rise masonry structures), which is used as the basis for estimating physical damage. The same structures are also categorized by their social function (e.g., hospital or school), which can be used, in conjunction with estimates of physical damage to the structures and dependent lifelines, to estimate deaths and injuries, as well as loss of function and restoration time.

Metropolitan Boston has a large variety of building stock that dates back more than 100 years. An engineering structure classification has been developed that groups the various types of structures in the study area into 24 engineering classifications. A social function classification system has also been developed for this study that relates each facility to the service it performs (e.g., residences, medical facilities, highways). The social function classification system developed for the study area includes 48 classifications and emphasizes critical facilities, especially lifelines, to respond to the project objective of establishing a basis for future earthquake hazard mitigation planning.

1.3.3 Inventory. A reliable inventory of man-made facilities is a basic requirement of a meaningful earthquake loss study. The results of even the best earthquake loss methodology can be undermined by an unreliable inventory. In general, the inventory for a seismic loss study requires data concerning the engineering and social function classifications of structures as well as their location, the number of structures, the density of population using the structure, and replacement value.

The challenge of compiling a reliable and sufficient inventory is primarily one of efficiency and economy rather than of technical capability. It is possible, given sufficient time and resources, to

compile a comprehensive inventory by field surveys. This approach is slow, laborious, and prohibitively expensive. Furthermore, the amount of detail from this direct approach is not necessary for the type of study being discussed here.

There are many alternatives to field surveys that can be used individually or in combination to compile the needed inventory. The first requirement of a cost-effective inventory is a clear scope of work, and the second is a knowledge of, and access to, available data and the experience to extract the needed inventory from such data.

A large number of federal, state, local, and private agencies maintain various types of data that are useful for such an inventory. The data available are not always current, and they are mostly compiled according to a classification scheme that is unique to the particular agency and not necessarily consistent with the schemes of other agencies. Nevertheless, these data banks are invaluable to seismic loss studies and can yield most of the inventory required when used properly.

Questionnaires, sampling techniques, land use maps, and aerial photographs, as well as expert opinion and inference, can also be used effectively to supplement the inventory. This study has depended heavily on available inventories from federal, state, and local government agencies to compile its inventory. Sampling and inference have also been used where necessary.

1.3.4 Structure Fragilities. Structure fragilities are the probabilities that a given structure class will sustain a given amount of damage in response to various levels of seismic shaking. Structure fragilities are developed and presented in numerous ways.

The structure fragilities used in this study are called damage probability matrices (DPMs). The DPM was first described by Martel [4] in

1964 and later developed by Whitman, Hong, and Reed [5] in 1973. This approach uses expert opinion and available earthquake damage data to establish fragilities for each class of structures as a function of a damage factor (DF) and intensity of shaking as defined by the MMI scale. The DF is defined as the ratio of dollar loss to replacement value.

1.3.5 Earthquake Loss Modeling. The choice of the central damage factor (CDF) as the basis for the structure fragilities is especially convenient for calculating direct physical damage. The number of structures in a given class and the replacement value of this class of structure are determined from the inventory and used to estimate the direct physical damage for a given intensity.

Deaths and injuries resulting from a postulated earthquake are usually assumed to be primarily due to the failure of man-made structures. Some deaths and injuries during past earthquakes have been a result of other earthquake-induced phenomena (e.g., tsunamis and slope failures). There is less information on deaths and injuries during past earthquakes than on building damage.

It is difficult to develop analytical models to predict casualties. People are highly mobile and are capable of taking actions during an earthquake that may significantly decrease or increase the potential for death or injury to themselves. Nevertheless, Anagnostopoulos and Whitman [6], among others, have used data from previous earthquakes to establish estimates of deaths and injuries as a function of structure type and extent of damage. It is clear that the estimates of deaths and injuries are a function of the time of day as well as the level of damage to structures. The population density in different types of buildings changes dramatically between day and night hours. Furthermore, during the night, large sectors of the population are asleep and relatively immobile, which may render them more vulnerable. Matrices used to estimate deaths, major injuries, and minor

injuries as a function of direct physical damage to various engineering classifications of structures have been developed for the structure classifications used in this study.

Loss of functionality of a given facility during an earthquake and the restoration time required to bring it back to full service are functions of a complex set of parameters that vary with each facility. A comprehensive evaluation of this subject is not possible using the current state of the art because of the paucity of available data from previous earthquakes. However, researchers in the U.S. and Japan have made some progress in developing methodologies to develop first estimates for the loss of functionality and restoration time of primary facilities. Specific factors affecting loss of functionality, or usability, include direct damage to the facility and equipment, damage to lifelines servicing the facility, personnel loss, and interruption of raw materials, supplies, replacement parts, and services to the facility. Subsequent restoration of functionality for a facility depends on degree of damage, importance of the facility for postearthquake recovery, and availability of manpower and resources.

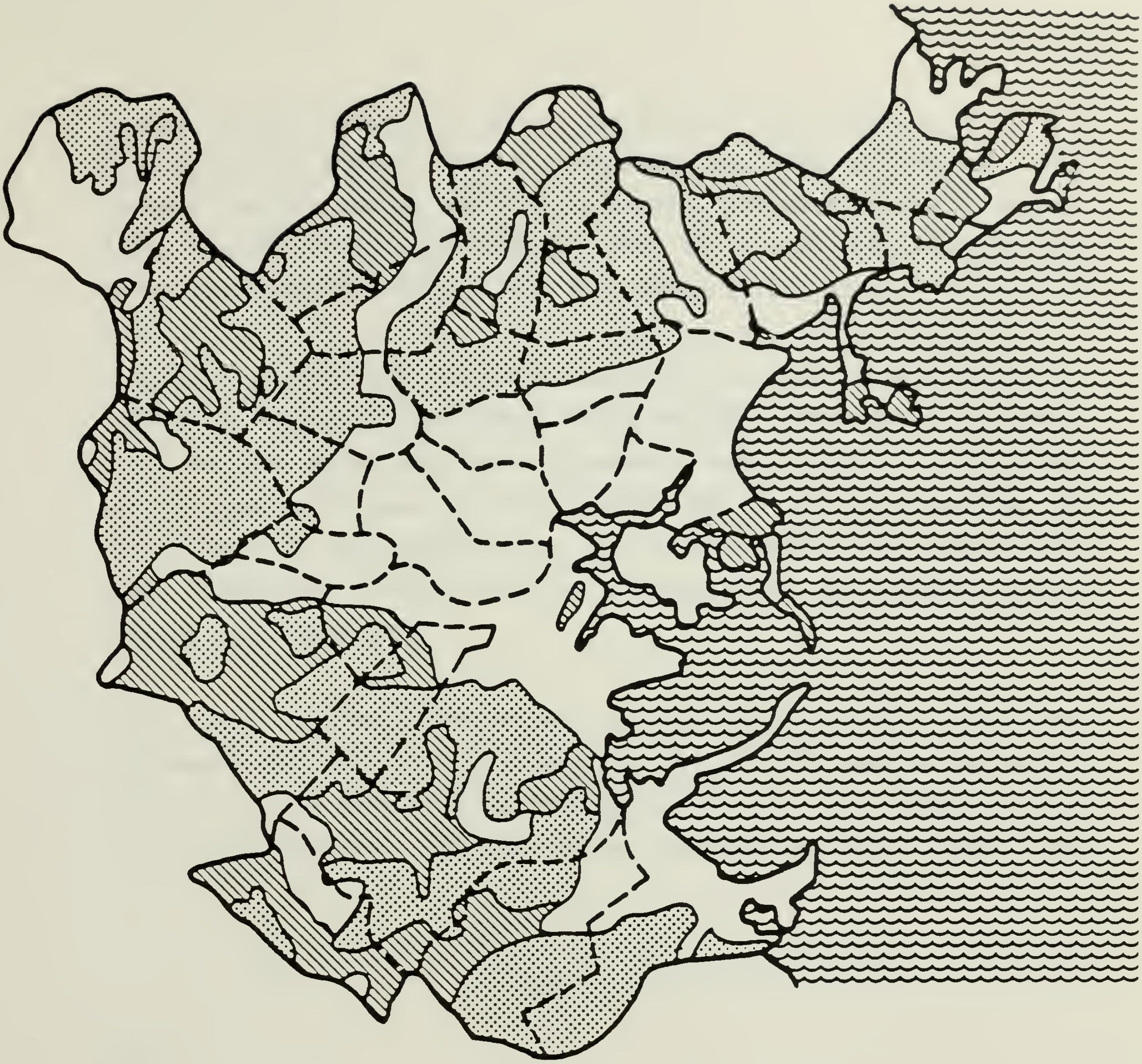
The most comprehensive approach attempted in the U.S. to date is that of the Applied Technology Council's study of earthquake loss evaluation data for California [7]; this is the basic approach proposed here. In this approach, matrices are developed that correlate direct physical damage with the number of days needed to restore the functionality of a facility of a given social function classification.

2. SEISMIC HAZARD

Metropolitan Boston has a moderate seismic hazard, as evidenced by the historical record of felt earthquakes in the area and by tectonics and seismicity studies. The geology of the northeastern United States (NEUS) is very complex, formed by several episodes of collisions and separations of the North American continent and Europe over the last 1,100 million years. The oldest rocks in the region are Precambrian igneous rocks, which presently lie in the Adirondack Mountains, Berkshires, Green Mountains, and Hudson Highlands. The present geology of the Appalachian region has been stable for the last 150 million years as a continental margin riding at the edge of the spreading Atlantic Ocean.

The bedrock in the NEUS is covered by a thick layer of glacial till. Metropolitan Boston has a highly variable surficial geology consisting of shallow, dense or stiff soils overlying bedrock; organic soils less than 30 ft thick overlying glacial till or bedrock; and nonengineered fills, organic soils, soft silts and clays, and loose granular soils exceeding 50 ft in thickness. Surficial geology may have a significant effect on earthquake damage, especially in poor soils (deep deposits of loose sands or soft clays) like those present in metropolitan Boston. This is especially true in the fill areas that abound in the Boston Harbor area. Figure 2.1 shows a general distribution of soils in the study area.

Historical data on the seismicity of the New England area are the earliest in the U.S. Diaries and journals of the early European settlers of the area include accounts of many small and a few moderate earthquakes. The 1727 and 1755 earthquakes east of Newbury, Massachusetts, in the vicinity of Cape Ann, are clearly the dominant events in the historical record. Both earthquakes are considered to have occurred offshore, and the worst observed damage was reported in



	SOIL TYPE	SEISMIC HAZARD	MMI
	Stiff Soils	1	V
	Intermediate Soils	2	VI
	Poor Soils	3	VII

FIGURE 2.1 General Distribution of Surface Soil Conditions and Seismic Hazard in Metropolitan Boston

coastal areas, where poor soils predominate. The November 9, 1727, earthquake was smaller than the November 18, 1755, earthquake. The maximum observed damage for the 1755 event is characterized by a Modified Mercalli Intensity (MMI) of VII, as indicated by chimney and structural damage, especially in the Boston Harbor area.

The seismic hazard for metropolitan Boston has been addressed in detail in a report by the Seismic Risk Analysis Subcommittee [3] prepared for the Massachusetts Civil Defense Agency (MCDA). A detailed set of quadrangle maps of the distribution of surficial geology in the study area was prepared by the firm of Haley and Aldrich for MCDA. These two reports are the foundation of the seismic hazard defined for this study.

This study considers the seismic hazard to be from a postulated earthquake with a body-wave magnitude (m_b) of 6.25 with an epicenter off the coast of Cape Ann, Massachusetts, at 70.3° west longitude and 42.7° north latitude. The attenuation relationship used in the study is:

$$I(R) = -1.43 + 1.79m_b - 1.83 \log R - 0.0018R \qquad (2.1)$$

where:

$I(R)$ = MMI at distance R for average soil conditions

R = Distance in kilometers

m_b = Body-wave magnitude

Application of this attenuation relationship to the study area gives an MMI of VI for the entire area for average soil conditions. Maps prepared by Haley and Aldrich were used to modify the intensities calculated in accordance with Equation 2.1 to reflect effects of surficial geology on earthquake damage. The consideration here was that Equation 2.1 gives an estimate of mean damage in the study area,

based on seismicity studies. Areas of poor soils are expected to sustain higher damage than the estimated mean, while areas with rock outcrops and firm stable soils are expected to sustain lower damage than the estimated mean. Thus, this study assumes a seismic hazard equivalent to MMI V, VI, and VII for areas with stiff soils, intermediate soils, and poor soils, respectively. Table 2.1 gives a description for these three soil classifications.

TABLE 2.1

CLASSIFICATION OF SOILS

Classification	Description
Stiff Soils	Bedrock, glacial till (exclusive of ablation tills), and deposits of other dense or stiff soils overlying bedrock that are less than 30 to 50 ft in thickness
Intermediate Soils	All soils not described by stiff or poor soils
Poor Soils	All areas with soils where combined thickness of non-engineered fills, organic soils, soft silts, and clays exceeds a range of 30 to 50 ft

3.1 General Description

Metropolitan Boston is located in the eastern portion of Massachusetts, an area most closely associated with the Route 128 transportation corridor. This region has a total population of approximately 1,800,000 and occupies about 275 square miles. The city of Boston serves as this area's central focus. See Table 1.1 for a breakdown by city of population and area. Known geologically as the Boston Basin, the region continues through Lynn and Saugus to the northwest and through Malden, Medford, Arlington, and Waltham to the west; it features rocky and sandy coastlines north to Salem and south to Quincy. Glacial activity left this region relatively smooth, with numerous gently sloping hills. Figure 3.1 is a map showing the 31 cities included in the study. The figure also shows the study area divided into nine cells, which were established for reporting earthquake losses and casualties.

Developing around a natural harbor, residential, commercial, and industrial activities began in this region over 300 years ago. Today, the port of Boston continues to play an active role in New England commerce and industry and is currently undergoing redevelopment. These waterfront facilities are among the nation's highest dollar ports, and the port of Boston provides services and benefits to those in inland Massachusetts as well.

Metropolitan Boston has been the commercial, financial, cultural, and political center of the state for over 200 years, and today the Boston and Cambridge area serves as one of the East Coast's leading technological, educational, and commercial centers. Commencing in about 1975, the city of Boston began an economic resurgence, symbolizing a strong local economy with a growing job base. New construction since 1975 has added over 14 million square feet of space

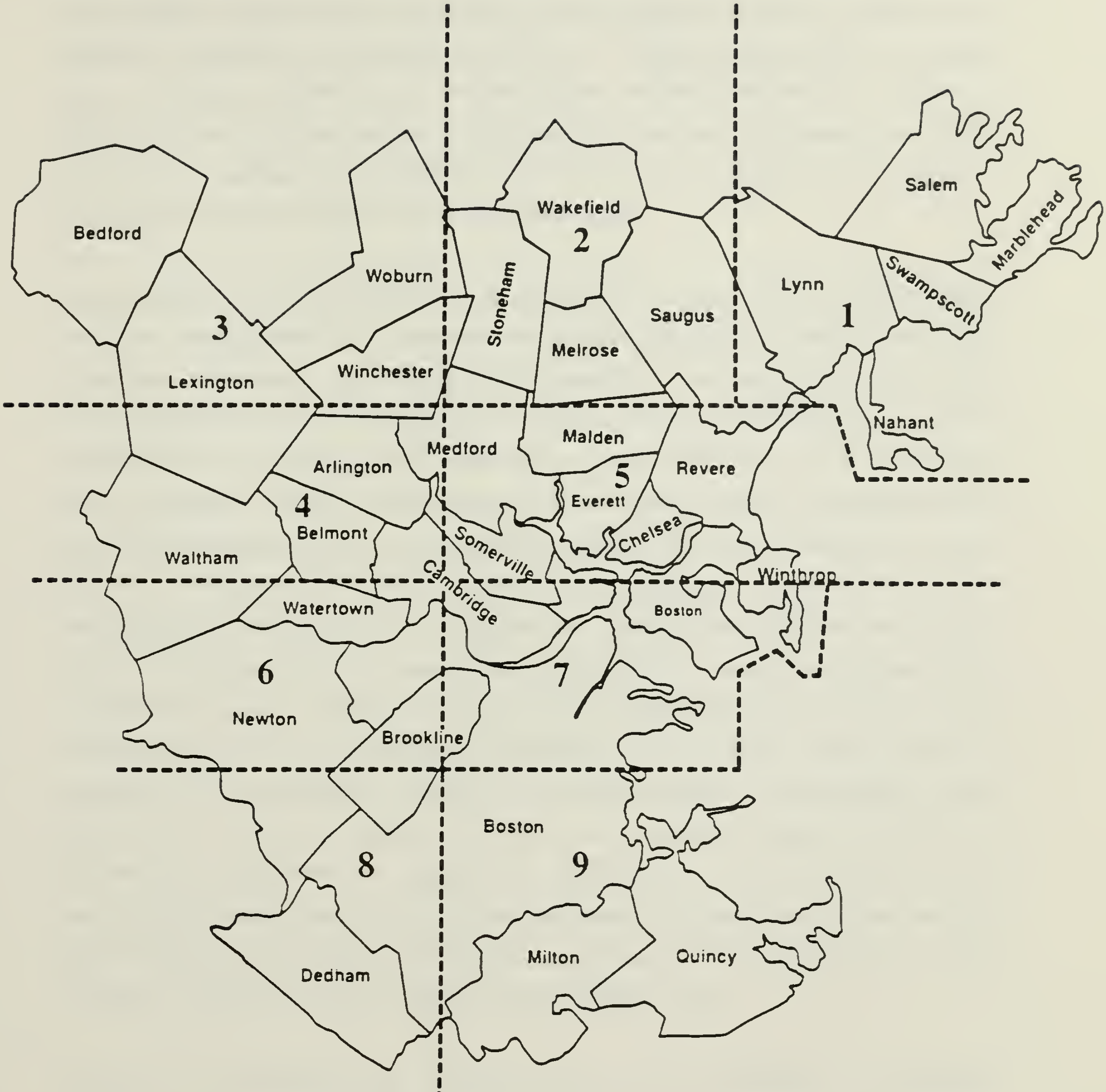


FIGURE 3.1 Map of Study Area Showing 31 Cities and Nine Cells

to the physical inventory of Boston, with a record amount of office space built and notable increases in the number of hotel rooms and in square footage of institutional space. Though continuing to advance with changing technology, metropolitan Boston strives to retain a sense of its history by preserving parks, natural features, and other historical landmarks commemorating events of the planning of American independence and of the Revolutionary War.

Evaluations of the impact of earthquakes on man and man-made works require determination in extensive detail of the properties and populations involved. In the type of inventory needed for the Metropolitan Boston Area Earthquake Loss Study, it is impossible to acquire needed data all having the same date. For example, the U.S. Government publishes census data every 10 years while other governments and agencies publish data on schedules unique to their needs or priorities. The data for this study were published, generally, in the period 1980 through 1987. Changes in population provide an indication of the accuracy or inaccuracy involved in using data compiled at different dates. Table 3.1a gives the population of the 31 cities included in the study for 1980 and 1986. This table shows that the population has remained essentially stable overall, with small losses in some of the surrounding cities, and also shows that the city of Boston has increased in population slightly. On this basis, it is our opinion that using data dated between 1980 and 1987 from various governments and agencies provides a reasonable approximation to the current inventory of the metropolitan Boston area.

Central to evaluating the economic impact of earthquakes on man-made works is the determination of the value of man-made facilities involved in the earthquake shaking. The most comprehensive data available in this regard are from the Massachusetts Department of Revenue. Table 3.1b lists the 1987 assessed values for residential, commercial, industrial, and personal property values for the 31 cities involved in the study. Because of Proposition 2-1/2, which was adop-

ted in Massachusetts in the late 1970s and implemented in FY 1981, all properties in Massachusetts are assessed at full and fair cash value and therefore includes land value. The assessed values must be updated every three years. Accordingly, the values given in Table 3.1b provide an important basis for the loss evaluations of this study.

The assessed values for residential, commercial, and industrial properties given in Table 3.1b include both building and land values. Government-owned land and facilities are not included in the values in Table 3.1b. In most communities, assessed personal property values are only a small percentage (2% to 3%) of the total assessed value. Personal property for a primary residence is not assessed in Massachusetts, but personal property at a second home is assessed. In communities where personal property assessments are material, the major contributor is private-sector equipment. Publicly owned but nongovernment equipment is assessed as personal property in Massachusetts. This includes items such as gas lines, electric power poles and lines, and (importantly) power generating equipment. The Boston Edison electric power generating equipment constitutes about one-half of the $1.7 billion in personal property assessment in Boston.

It is noteworthy that residential property values are very dominant in connection with the overall value of the metropolitan Boston area. This is typical of virtually all communities.

TABLE 3.1a

POPULATIONS OF CITIES INCLUDED IN THE

METROPOLITAN BOSTON AREA EARTHQUAKE LOSS STUDY

City	Population* (1980)	Population** (1986)
Arlington	48,219	44,350
Bedford	13,067	12,490
Belmont	26,100	25,020
Boston	562,994	573,600
Brookline	55,062	52,360
Cambridge	95,322	91,260
Chelsea	25,431	25,640
Dedham	25,298	23,810
Everett	37,195	36,330
Lexington	29,479	28,610
Lynn	78,471	78,560
Malden	53,386	53,490
Marblehead	20,126	19,580
Medford	58,076	56,830
Melrose	30,055	28,790
Milton	25,860	25,500
Nahant	3,947	3,940
Newton	83,622	82,140
Quincy	84,743	82,630
Revere	42,423	43,510
Salem	38,220	38,050
Saugus	28,476	25,860
Somerville	77,372	72,280
Stoneham	21,424	22,550
Swampscott	13,837	13,330
Wakefield	24,895	25,170
Waltham	58,200	57,090
Watertown	34,384	32,890
Winchester	20,710	20,120
Winthrop	19,294	18,640
Woburn	36,626	37,380
Total	1,771,314	1,751,800

* Source: U.S. Census Data, 1980

** Source: Massachusetts Department of Revenue

TABLE 3.1b

ASSESSED VALUES OF PROPERTIES IN THE

METROPOLITAN BOSTON AREA EARTHQUAKE LOSS STUDY

City	Residential	Commercial	Industrial	Personal
Arlington	$1,646,778	$125,532	$16,554	$25,869
Bedford	641,227	247,837	307,482	17,763
Belmont	1,303,942	121,789	8,151	6,605
Boston	11,425,508	9,290,057	1,059,836	1,734,251
Brookline	1,949,950	237,863	4,589	41,252
Cambridge	3,578,489	1,728,000	519,006	149,534
Chelsea	284,869	143,300	51,612	21,306
Dedham	750,901	163,093	69,975	25,550
Everett	600,047	105,162	325,802	389,444
Lexington	2,235,803	478,384	148,788	38,851
Lynn	2,285,457	326,837	216,397	56,958
Malden	1,052,716	147,200	84,417	40,644
Marblehead	1,353,565	85,587	12,498	8,899
Medford	1,491,318	232,241	50,549	26,967
Melrose	1,314,107	61,694	12,958	14,223
Milton	819,006	32,629	5,042	16,220
Nahant	274,498	7,372	70	2,862
Newton	5,516,689	968,454	133,934	86,303
Quincy	2,800,133	736,162	211,867	70,722
Revere	1,487,453	280,610	13,283	24,985
Salem	912,707	187,021	108,700	211,716
Saugus	997,298	222,103	65,466	29,181
Somerville	1,505,673	316,330	96,943	57,622
Stoneham	575,645	84,413	12,329	11,708
Swampscott	971,244	60,289	4,581	8,164
Wakefield	1,157,765	207,034	59,572	9,159
Waltham	1,439,637	620,452	307,488	75,314
Watertown	1,211,805	174,111	166,616	25,896
Winchester	1,429,723	76,894	27,953	20,584
Winthrop	400,199	28,966	793	7,200
Woburn	1,438,967	427,185	512,908	64,625
Total	$54,853,119	$17,924,601	$4,616,159	$3,320,377

1987 values in thousands of dollars
Source: Massachusetts Department of Revenue

3.2 Inventory Scope

This study has compiled a detailed inventory of all critical facilities. These include, for example, residences, schools, and structures associated with vital and essential urban services and facilities.

This inventory is intended to provide a sufficiently detailed record of relevant construction and structural factors, facility values, and associated population and occupancy data to allow for estimates of damage, functionality, and casualties. Table 3.2 lists the loss evaluation elements included in the study. This table largely defines the scope of the inventory. Specific information sought for each of the broad classifications listed in Table 3.2 is described in Sections 3.4 through 3.13, which give the inventory data.

In addition, the inventory included determination of the values of residential, commercial, and industrial property values and population data to assess overall economic impact and casualties. Basic data pertaining to overall property values is given in Table 3.1b, and population data are given in Table 3.1a.

TABLE 3.2

INVENTORY SCOPE FOR THE

METROPOLITAN BOSTON AREA EARTHQUAKE LOSS STUDY

1. **MEDICAL FACILITIES AND RESOURCES**
   - Hospitals
   - Nursing Homes
   - Ambulance Service
   - Medical Supply Houses
   - Blood Banks
   - Clinical Labs
   - Health Manpower

2. **TRANSPORTATION FACILITIES AND SYSTEMS**
   - Highway System
   - Airport Facilities
   - Water Port Facilities
   - Public Transportation System

3. **GAS AND PETROLEUM FUEL UTILITIES**
   - Natural Gas
   - Petroleum Fuel

4. **WATER AND SEWERAGE UTILITIES**

5. **ELECTRIC POWER UTILITY**

6. **COMMUNICATIONS NETWORK**
   - Telephone
   - Radio
   - Television

7. **EMERGENCY PUBLIC FACILITIES**
   - Police Stations
   - Fire Stations
   - Civil Defense Emergency Operating Centers
   - National Guard Armories

8. **RESIDENTIAL BUILDINGS**

9. **SCHOOL BUILDINGS**

10. **SPECIAL FACILITIES**
    - Dams
    - Tall Buildings

3.3 Inventory Methodology

Several methods can be applied to develop a data base for inventory purposes. Section 1.3 gives an overview of the importance of an inventory for earthquake loss studies. As mentioned there, an inventory that perfectly fits the specifications of the study can be compiled through the use of field studies to precisely determine the values and earthquake vulnerabilities of all facilities in a study area. This proves to be costly and time-consuming and, in a study of this nature, is impractical.

Many firms and agencies have established data banks containing the type of information this study needed. The study first sought existing data banks to furnish the information required for the analysis. Where these data banks did not fulfill the study's requirements, supplemental information was obtained through personal interviews, questionnaires, telephone surveys, sampling, expert opinion, and construction standards for cost estimating.

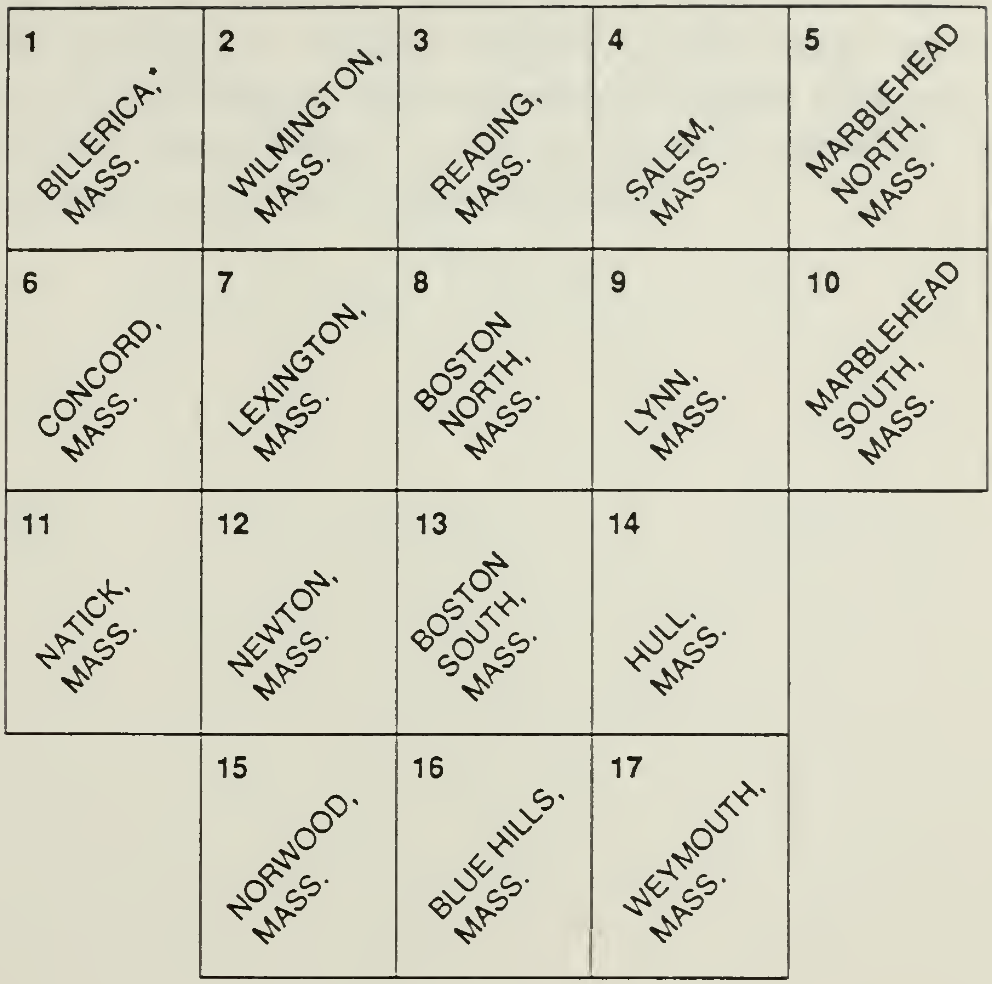
Detailed information was gathered in connection with each of the ten facility categories listed in Table 3.2. For electric power, for example, the following components were inventoried: generating stations, major transmission lines, major substations, and distribution lines. The information sought for each of these components included: location for determining the applicable seismic hazard and for determining the importance of the component to the electric power system, the engineering classification of the component, and the replacement value of the facility. The inventory data gathered for each facility category component were recorded in one or both of two ways: (1) the data were computerized using dBASE software; (2) the data were mapped (overlaid) on standard U.S. Geological Survey topographic maps (scale 1:25,000). The seismic hazard maps prepared by Haley and Aldrich (see Chapter 2) were prepared using the same map scale.

A total of 17 map sheets, at the scale of 1:25,000, were required to cover the entire study area. Figure 3.2 shows the map grid system and grid map numbers established for this study along with the U.S. Geological Survey map names. A total of nine map sets, including a total of 121 map sheets, were prepared to map the facilities inventoried. Table 3.3 summarizes the maps prepared in connection with the study. These maps were prepared for MCDA's use and are not included in this report.

The inventory data for the various facility components included in the dBASE library are given in Sections 3.4 through 3.13.

An important aspect of a general earthquake loss evaluation such as this is that the reported loss estimates are not regarded as site-specific. In spite of the substantial rigor involved in this study, no single facility has been examined in sufficient detail to make it possible to estimate the specific dollar damage, loss of function, or casualties that might result from the postulated earthquake. For this study, we have elected to use 10 as the minimum number of facilities or components for which losses are reported. This is regarded as a number sufficient to ensure facility anonymity. Accordingly, the inventory summaries of facility values and classifications given in Sections 3.4 through 3.13 are presented using this same criterion. The engineering classifications specified for various facilities in Sections 3.4 through 3.13 are based on the classifications developed for the study and given in Table 4.1. Social function classifications (see Table 4.2) are not specified in the inventory tables given in Sections 3.4 through 3.13 because they are obvious.

In developing the input data for the computer analyses of losses and casualties, all inventory data were compiled by cell, and losses and casualties were calculated for each of the nine cells. The only exception is that, for main components of lifelines, all inventory items were aggregated over the entire study area for each lifeline,



* U.S. Geological Survey Map Name - Scale 1: 25,000

FIGURE 3.2 Map Grid Numbering System for Facility Inventory Maps

and only the seismic hazard zones were distinguished. This is consistent with the analytical methodology for calculating losses described in Chapter 4. Railways, highways, airport runways and taxiways, and pole-supported electric power distribution lines were not inventoried because damage to these facilities is estimated to be inconsequential for the postulated earthquake.

TABLE 3.3

SUMMARY OF FACILITY INVENTORY MAPS PREPARED

MAP NUMBER	FACILITIES MAPPED	NUMBER OF MAP SHEETS
1	Transportation Facilities	15
2	Water and Sewerage Facilities	16
3	Natural Gas and Petroleum Fuel Facilities	17
4	Electric Power Facilities	14
5	Schools and Dams	17
6	Tall Buildings	1
7	Emergency Response Facilities	13
8	Medical Facilities	14
9	Communications Facilities	14

3.4 Medical Facilities and Resources

3.4.1 Overview. The medical facilities and resources category includes hospitals, nursing homes, ambulance services, medical supply houses, blood banks, clinical laboratories, and health manpower.

Hospitals: Only hospitals having 100 or more beds were included in the study, yielding a total of 55 hospitals. The largest hospitals are in Boston, with Massachusetts General Hospital having 1,082 beds, the Veterans Administration Medical Center having 732 beds, and Brigham & Women's Hospital having 713 beds.

Many of the hospitals in the greater Boston area began as small structures, and larger modern wings were added to the original structure as the facility grew. For example, Quincy City Hospital was built in 1936 as a three-story colonial brick structure. The hospital was expanded by the addition of large modern wings to the colonial structure.

The original building of Massachusetts General (the largest hospital in the study area) was first constructed in 1811. Affiliated with Harvard Medical School, this teaching hospital has grown to its present status of 20 buildings on 13-1/2 acres, representing over 40 medical disciplines. Approximately 8,000 staff are employed at the facility. It is a state law in Massachusetts that all hospitals have backup power. Table 3.4a details the inventory of hospitals for the study area.

Nursing Homes: Nursing homes and convalescent facilities with fewer than 30 beds were not included in the study. Of those facilities having 30 or more beds, the three largest are in Boston, with 376, 240, and 200 beds, respectively. As with the hospitals, the largest number of nursing homes is in Boston. The Public Health Department requires that all Level I and Level II facilities have backup power.

A total of 173 nursing homes in the metropolitan Boston area were included in the study. These facilities are detailed in Table 3.4b.

Ambulance Services: Twelve ambulance services were included in the study on the condition that they operate five or more cars. The largest service (38 vehicles) is based in Malden, and the second largest (22 vehicles) is in Boston proper. Both of these services provide advanced life support and paramedic service. Massachusetts state law requires that all ambulances be garaged.

There is one air ambulance service in the study area. Located in Boston, this service has four aircraft, most of which are hangared at facilities outside the study area (e.g., Groton, Connecticut). Although other air ambulance services provide support to the Boston area, the services themselves are located outside the study area. Table 3.4c details the inventory of ambulance services.

Medical Supply Houses: Seven medical supply houses were identified in the study area. These business provide hospitals and other medical facilities with medical, surgical, pharmaceutical, and laboratory supplies. These supply houses are located in Medford, Woburn, Bedford, Cambridge, Stoneham, Boston, and Malden. The inventory of medical supply houses is listed in Table 3.4d.

Blood Banks: The nine blood banks listed in Table 3.4e either are independent of any hospital (e.g., the American Red Cross in Dedham) or are located in hospitals not identified in the hospital inventory because they have fewer than 100 beds. Over 50% of the blood banks are in Boston.

Clinical Laboratories: The designation of clinical laboratories also includes diagnostic facilities, pathology laboratories, some research facilities, and medical clinics. These medical clinics are not di-

rectly associated with a hospital, and they usually have their own laboratories and blood supplies.

Sixty facilities in this category were identified in the study area. The majority of the facilities are located in Boston, Brookline, and Cambridge. Of the 60, 25 are in Boston. Table 3.4f details the inventory of clinical laboratories.

Health Manpower: According to the Massachusetts *Health Data Annual, 1977,* over 6,000 physicians and over 16,000 nurses are licensed in the study area. Of these totals, 50% of the doctors and nurses are licensed in Boston proper. A more current census was not available at the time this information was acquired. Table 3.4g details the health manpower distribution for physicians and registered nurses throughout the study area for the 1977 time period.

The Public Health Department no longer compiles the statistics that were provided in the *Health Data Annual*: 1977 was the last year this type of reporting was done. The licensing boards for physicians and registered nurses were also unable to report this information by town in the manner desired. The Physician's Assistants Board reported approximately 500 physician's assistants throughout Massachusetts but could not provide a breakdown by city and town. The Emergency Medical Technicians Board listed only individuals who have taken their training, but the records do not indicate emergency medical technicians actually working in the medical field. Therefore, only physicians and registered nurses could be inventoried.

Folio Associates, Inc., a firm that compiles an annual directory for physicians, was able to provide a February 1988 listing of physicians by town. The numbers may be slightly high because the physicians are allowed to list two locations if they wish.

3.4.2 Engineering Classifications and Replacement Values. The engineering classifications for all medical facilities and resources sampled in the study area are detailed in Table 3.4h.

Engineering classifications for hospitals, nursing homes, ambulance services, medical supply houses, and clinical laboratories were established through sampling. The number sampled and total number of facilities for each type are indicated in Table 3.4h. The majority of blood banks are located within hospitals; therefore, the structure classification for blood banks was assumed to be the same as that for hospitals. Replacement values for all medical facilities and resources are detailed by cells and seismic hazard zones in Table 3.4i.

TABLE 3.4a

MEDICAL FACILITIES AND RESOURCES

HOSPITALS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	# BEDS	% OCC.	BLOOD BANK	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
H 1	ARLINGTON	SYMMES HOSPITAL	HOSPITAL ROAD	GENERAL W/O MATERN.	305		YES				1
H 2	BEDFORD	EDITH NOURSE RO	200 SPRINGS RD.	GENERAL W/O MATERN.	913	91.5	YES				1
H 3	BELMONT	MCLEAN HOSPITAL	115 MILL ST.	MENTAL HEALTH	328	90.5	NO				1
H 4	BOSTON	BETH ISRAEL	330 BROOKLINE AVE.	GENERAL W/MATERNITY	464	89.0	YES				3
H 5	BOSTON	BOSTON CITY	818 HARRISON AVE	GENERAL W/MATERNITY	451	79.6	YES				3
H 6	BOSTON	BRIGHAM & WOMEN'S	75 FRANCIS	GENERAL W/MATERNITY	713	87.7	YES				3
H 7	BOSTON	CARNEY HOSPITAL	2100 DORCHESTER AVE	GENERAL W/O MATERN.	391	83.2	YES	MASONRY	MED.	1960's	3
H 8	BOSTON	CHILDREN'S HOSPITAL	300 LONGWOOD AVE	PEDIATRIC/SPEC.ADULT	339	83.2	YES				3
H 9	BOSTON	FAULKNER HOSPITAL	1153 CENTRE ST.	GENERAL W/O MATERN.	259	84.2	YES	MASONRY	MED.	1970'S	1
H10	BOSTON	HEBREW REHAB.	1200 CENTRE ST	CHR.DIS.& REHAB.INST	725	97.4	NO				1
H11	BOSTON	J.P.KENNEDY HOSPITAL	30 WARREN ST.	PEDIATRICS & REHABIL	100	73.0	YES	MASONRY	LOW	1947	2
H12	BOSTON	JEWISH MEM.HOSPITAL	59 TOWNSEND ST.	CHRONIC DISEASE	207	88.4	YES				1
H13	BOSTON	LEMUEL SHATTUCK	170 MORTON ST.	CHRONIC DISEASE	250	82.4	YES	REIN. CONC.	HIGH	1970'S	1
H14	BOSTON	MASS.EYE & EAR	243 CHARLES ST.	EYE,EAR,NOSE,THROAT	174	82.8	NO				3
H15	BOSTON	MASS.GENERAL	32 FRUIT ST.	GENERAL W/O MATERN.	1082	84.8	YES				3
H16	BOSTON	MASS.REHAB.HOSPITAL	125 NASHUA ST.	CHRONIC DISEASE	284	91.5	NO	REIN. CONC.	HIGH	1970	3
H17	BOSTON	MATTAPAN HOSPITAL	249 RIVER ST.	CHRONIC DISEASE	165	83.6	NO				3
H18	BOSTON	NEW ENG.BAPTIST	91 PARKER HILL AVE.	GENERAL W/O MATERN.	245	89.8	YES				1
H19	BOSTON	NEW ENG.DEACONESS	185 PILGRIM RD.	GENERAL W/O MATERN.	489	88.1	YES	MASONRY	MED.	1975	3
H20	BOSTON	NEW ENG.MED.CTR.	171 HARRISON AVE	GEN.W/O MAT.&REHAB.	444	87.2	YES				3
H21	BOSTON	ST.ELIZABETH'S	736 CAMBRIDGE ST.	GENERAL W/ MATERN.	386	88.3	YES				2
H22	BOSTON	ST.MARGARET'S	90 CUSHING AVE.	GENERAL W/MATERN.	113	96.5	YES	MASONRY	MED.	1960's	1
H23	BOSTON	THE ARBOUR	49 ROBBINWOOD AVE.	SHORT TERM PSYCHIAT.	115	81.7	NO				1
H24	BOSTON	UNIVERSITY HOSPITAL	75 E NEWTON ST.	GENERAL W/O MATERN.	379	87.3	YES				3
H25	BOSTON	ROXBURY V.A. HOSPITAL	1400 VFW PARKWAY	ACUTE,MED.SURGICAL	279	76.2	YES				1
H26	BOSTON	V.A.MED.CTR.	150 S.HUNTINGTON AVE	ACUTE, MED. SPINAL	732	76.9	YES				1
H27	CAMBRIDGE	CAMBRIDGE HOSPITAL	1493 CAMBRIDGE ST.	GENERAL W/MATERN.	182	70.9	YES				3
H28	CAMBRIDGE	MT.AUBURN HOSPITAL	330 MT.AUBURN ST.	GENERAL W/ MATERN.	305	82.8	YES				3
H29	CAMBRIDGE	OTIS HOSPITAL	85 OTIS ST.	CHRONIC DISEASE	109	95.4	NO				2
H30	CAMBRIDGE	SANCTA MARIA HOSP.	799 CONCORD AVE.	GENERAL W/O MATERN.	150	72.7	YES				3

TABLE 3.4a (cont.)
MEDICAL FACILITIES AND RESOURCES
HOSPITALS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	# BEDS	% OCC.	BLOOD BANK	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
H31	CAMBRIDGE	YOUVILLE REHAB.	1575 CAMBRIDGE ST.	CHRONIC DIS.& REHAB.	305	97.0	NO				3
H32	CHELSEA	SOLDIER'S HOME	91 CREST AVE.	LONG TERM CARE	150	80.7	YES				2
H33	EVERETT	WHIDDEN MEM.HOSP.	103 GARLAND ST.	GENERAL W/O MATERN.	173	90.8	YES				2
H34	LYNN	LYNN HOSPITAL	212 BOSTON ST.	GENERAL W/ MATERN.	301	75.7	YES	MASONRY	LOW	1920's	2
H35	LYNN	UNION HOSPITAL	500 LYNNFIELD ST.	GENERAL W/O MATERN.	210	80.0	YES	MASONRY	LOW	-	1
H36	MALDEN	MALDEN HOSPITAL	HOSPITAL RD.	GENERAL W/MATERN.	241	76.3	YES				1
H37	MEDFORD	LAWRENCE MEM.HOSP.	170 GOVERNOR'S AVE.	GENERAL W/O MATERN.	200	73.5	YES	MASONRY	MED.	1975	1
H38	MELROSE	MELROSE-WAKEFIELD H.	585 LEBANON ST.	GENERAL W/MATERN.	256	87.5	YES				2
H39	MILTON	MILTON HOSPITAL	92 HIGHLAND ST.	GENERAL W/O MATERN.	161	78.3	YES				1
H40	QUINCY	LONG ISLAND HOSPITAL	BOSTON HARBOR	CHRONIC DISEASE	285	0.0	NO				1
H41	QUINCY	QUINCY CITY HOSPITAL	114 WHITWELL ST.	GENERAL W/MATERN.	330	83.9	YES	REIN. CONC.	HIGH		1
H42	REVERE	GROVER MANOR HOSP.	405 WASHINGTON AVE.	GEN.W/O MATERN.CHRON	161	99.4	NO				3
H43	SALEM	DR.RJ.SHAUGHNESSY	DOVE AVE	CHR.DIS.& REHAB.	160	85.6	NO				1
H44	SALEM	SALEM HOSPITAL	81 HIGHLAND AVE.	GENERAL W/MATERN.	379	82.6	YES				1
H45	SOMERVILLE	SOMERVILLE HOSPITAL	230 HIGHLAND AVE.	GENERAL W/O MATERN.	138	75.4	YES				2
H46	STONEHAM	NEW ENG.MEM.HOSPITAL	5 WOODLAND RD.	GENERAL W/MATERN.	301	82.1	YES				1
H47	WALTHAM	METROPOL.ST.HOSPITAL	475 TRAPELO RD.	PSYCHIATRIC CARE	413	87.8	NO				1
H48	WALTHAM	MIDDLESEX CO.HOSP.	775 TRAPELO RD.	TUBER.&CHR.DISEASE	170	90.0	NO				1
H49	WALTHAM	W.E.FERNALD SCHOOL	200 TRAPELO RD.	MENTAL HEALTH	940	95.2	NO				1
H50	WALTHAM	WALTHAM HOSPITAL	HOPE AVE.	GENERAL W/MATERN.	305	77.7	YES				1
H51	WINCHESTER	WINCHESTER HOSPITAL	41 HIGHLAND AVE.	structure/MATERN.	195	81.0	YES				1
H52	WINTHROP	WINTHROP HOSPITAL	40 LINCOLN ST.	GENERAL W/O MATERN.	110	79.4	YES				2
H53	WOBURN	CHOATE-SYMMES HOSP.	21 WARREN AVE.	GENERAL W/O MATERN.	315	73.7	YES				1
H54	WOBURN	NEW ENG.REHAB.	TWO REHABILITATION W	REHABILITATION	198	98.0	NO				1
H55	NEWTON	NEWTON-WELLESLEY HOS	2014 WASHINGTON ST.	GENERAL W/MATERNITY	351	83.7	NO	REIN. CONC.	MED.	1963	2

TABLE 3.4b

MEDICAL FACILITIES AND RESOURCES

NURSING HOMES

CODE	CITY	FACILTY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N 1	ARLINGTON	HILLSIDE NURSING HM	163 HILLSIDE AVE	A,B,D,E,F,G,H	III	50				1
N 2	ARLINGTON	PARK AVE.NURSING HM	146 PARK AVE.	A,B,E,F,G,H	II,III	80				1
N 3	ARLINGTON	WELLINGTON MANOR N.H	8 WELLINGTON ST.	A,B	III	43				1
N 4	BEDFORD	CARLETON-WILLARD VIL	100 OLD BILLERICA RD	1,(NP)	II,III,IV	120				1
N 5	BELMONT	BELMONT MANOR NUR.H.	34 AGASSIZ AVE	A,B,C,D,E,F,G,H	II,III	119				1
N 6	BOSTON	ALLSTON NURSING HOME	533 CAMBRIDGE ST.	GERI-CARE,E,G,H	III	152				2
N 7	BOSTON	ALMEIDA NURSING HOME	69 ROBESON ST.	H	III	30				1
N 8	BOSTON	ARBORWAY MANOR CONVA	55 BURROUGHS ST.	E,F,G,H	III	32				2
N 9	BOSTON	ARMENIAN NURSING HM.	431 POND ST.	A,B,C,D,E,F,G,H	II,III	83				1
N 10	BOSTON	ASHMONT MANOR	45 COFFEY ST.	A,B,E,H	III	77				3
N 11	BOSTON	AUBURN HOUSE NURSING	9 REVERE ST.	A,B,E,F,H	III	71				1
N 12	BOSTON	BAYSIDE NURSING HOME	804 E.7TH ST.	A,B,D,E,F	II,III	103				3
N 13	BOSTON	BEATRICE MARIE NUR.H	337 NEPONSET AVE.	1,2,3,4,5,6,7	III,IV	109				3
N 14	BOSTON	BIGELOW NURSING HOME	142 BIGELOW ST.	B,E,F,G,H	III	143				2
N 15	BOSTON	BIRCH HAVEN NURSING	123 CRAWFORD ST.	E,H	III	38				1
N 16	BOSTON	BOSTON HOME, INC.	2049-2061 DORCHESTER	A,B,E,F,G (NP)	II	42				1
N 17	BOSTON	BRADFORD CONVALESCT.	214 HARVARD ST.	H	III	91				1
N 18	BOSTON	CENTRE MANOR NURSING	45 CENTRE ST.	B,E,F,G,H	III	84				3
N 19	BOSTON	CHARLES HOUSE CONVAL	10 BELLAMY ST.	A,B,E,F,G,H	II,III	121				2
N 20	BOSTON	CHESTNUT HILL NURS.H	35 CHESTNUT HILL AVE	A,B,E,F,G	III	48				2
N 21	BOSTON	CIRCLE MANOR NURS.HM	29 CHESTNUT HILL AVE	F,H	III	64				2
N 22	BOSTON	COLUMBIA NURSING HM.	1380 COLUMBIA RD.	A,B,D,E,H	III	107				3
N 23	BOSTON	COLUMBUS NURSING HM.	910 SARATOGA ST.	A,B,E,F,G,H	I,II,III	164				3
N 24	BOSTON	CUSHING MANOR REST H	20 CUSHING AVE.	2,4,5,6	IV	36				1
N 25	BOSTON	DENNIS NURSING HOME	3 ASPINWALL RD.	H	III	49				1
N 26	BOSTON	DEUTSCHES ALTENHELM	2222 CENTRE ST.	A,H (NP)	III,IV	40				1
N 27	BOSTON	DON ORIONE NURSING H	111 ORIENT AVE.	A,B,C,D,E,F,G,H	II,III(NP)	200				2
N 28	BOSTON	DUPLEX NURSING HOME	12 HARRIS AVE.	A,B,D,H	III	46				1
N 29	BOSTON	EDGEWOOD NURSING HM.	637 WASHINGTON ST.	A,B,D,E,F,G,H	II,III	100				2
N 30	BOSTON	ELIZABETH CARLETON H	2055 COLUMBUS AVE.	1,2,3,4,5,6,7	III,IV(NP)	110				1

TABLE 3.4b (cont.)
MEDICAL FACILITIES AND RESOURCES
NURSING HOMES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N 31	BOSTON	ELLEN JAMES REST HM	42 ELM HILL AVE.	1,2,4,5,6,7	IV	40				1
N 32	BOSTON	ELM HILL NURSING HM.	241 WALNUT AVE.	F,H	III	58	WOOD	LOW	1921	1
N 33	BOSTON	ENGLEWOOD NURSING HM	27 HOWLAND ST.	E,F,G,H	III	35	WOOD	LOW	1956	1
N 34	BOSTON	FAIRMOUNT REST HOME	172 FAIRMOUNT AVE.	1,2,3,4,5,6,7	III	32	WOOD	LOW	1922	1
N 35	BOSTON	FOREST HILLS NURSING	101 BROOKLEY RD.	A,B,D,E,F,G,H	III	112	REIN. CONC.	LOW	1964	3
N 36	BOSTON	FRANK WOOD CONVALSCT	1135 MORTON ST.	REHAB.FRAC.HIPS	I	58	MASONRY	MED.	1952	1
N 37	BOSTON	GREENERY NURSING HM	99-111 CHESTNUT HILL	A,B,C,D,E,F,G,H	I,II,III	198	MASONRY	LOW	1960	2
N 38	BOSTON	HALE HOUSE	273 CLARENDON ST	1,2,4,5,6,7(NP)	IV	56	MASONRY	MED.	1917	3
N 39	BOSTON	HIGHLAND REST HOME	516 WARREN ST.	1,2,4,5,6	IV	41	WOOD	LOW	1944	1
N 40	BOSTON	HILLTOP MANOR NUR.HM	30 HILLTOP ST.	B,H	III	90	MASONRY	LOW	1922	3
N 41	BOSTON	HOGDON REST HOME	95 MORELAND ST.	1,2,3,4,5,6,7	IV	60	WOOD	LOW	1920	1
N 42	BOSTON	HOME FOR AGED WOMEN	201-205 S.HUNTINGTON	1,2,3,4,5,6,7	III,IV(NP)	145	MASONRY	MED.	1931	1
N 43	BOSTON	HYDE PARK CONVAL.HM.	113 CENTRAL AVE.	B,D,E,H	III	54				1
N 44	BOSTON	JAMAICA TOWERS NURS.	174 FOREST HILLS ST.	A,B,C,D,E,F,G,H	I,II,III	120	MASONRY	LOW	1969	1
N 45	BOSTON	JOHNSON NURSING HOME	46 WREN ST.	A,B,C,D,E,F,G,H	III	32				1
N 46	BOSTON	MARCO POLO REST HOME	321 PRINCETON ST.	2,4,5,6,7	IV	62				2
N 47	BOSTON	MAREGAN MANOR NUR.HM	133 HANCOCK ST.	E,G,H	III	76	MASONRY	LOW	1960	1
N 48	BOSTON	MARIAN MANOR NURSING	130 DORCHESTER ST.	A,B,C,D,E,F,G,H	II,III,IV	376				1
N 49	BOSTON	MARTIN NURSING HOME	415 COLUMBIA RD.	A,B,D,E,H	III	150				1
N 50	BOSTON	MARY MURPHY NURSING	70 ROCKVIEW ST.	B,E,F,G,H	III	91				1
N 51	BOSTON	MILTON VIEW NURS.HM.	150 RIVER ST.	A,B,C,D,E,F,G,H	III	64				3
N 52	BOSTON	MONROE REST HOME	72 ROBINWOOD AVE.	2,3,4,5,6,7	IV	33				1
N 53	BOSTON	MT.PLEASANT HOME	301 S.HUNTINGTON AVE	1,2,6	IV (NP)	42				1
N 54	BOSTON	NEPONSET HALL	35 COFFEY ST.	A,B,E,H	III	98				3
N 55	BOSTON	OAK HAVEN NURSING HM	74 HOWLAND ST.	A,B,C,D,E,F,G,H	III	42				1
N 56	BOSTON	PARKWAY NURSING HOME	1190 VFW PARKWAY	A,B,D,E,F,H	II,III	140				1
N 57	BOSTON	PARKWELL NURSING HM.	745 TRUMAN HIGHWAY	A,B,C,E,F,G,H	I,III	124				1
N 58	BOSTON	PARLEY VALE REST HM.	3 PARLEY VALE	1,2,6	IV (NP)	42				1
N 59	BOSTON	PROVIDENT NURSING HM	1501 COMMONWEALTH AV	B,E,H	III	146				2
N 60	BOSTON	RECUPERATIVE CENTER	1245 CENTRE ST.	A,B,D,E,F,G	I (NP)	50				1

TABLE 3.4b (cont.)
MEDICAL FACILITIES AND RESOURCES
NURSING HOMES

CODE	CITY	FACILTY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N 61	BOSTON	REGENT NURSING HOME	74 COREY RD.	H	III	41				1
N 62	BOSTON	RESTHAVEN CORP.(NP)	120 FISHER AVE.	A,B,C,E,F,G,H	II,III,IV	240				1
N 63	BOSTON	REVERE MANOR NURS.HM	11 REVERE ST.	A,B,E,F,H	III	44				1
N 64	IOSTON	RIVERSIDE NURSING HM	405 RIVER ST.	A,B,C,D,E,G,H	II	85				3
N 65	BOSTON	ROBINWOOD II REST HM	87 ROBINWOOD AVE.	2,3,4,5,6,7	IV	31				1
N 66	BOSTON	ROGERSON HOUSE	434 JAMAICA WAY	1,2,3,4,5,6,7	III,IV	56				2
N 67	BOSTON	SHERIFF MANOR NURS.	176 HUMBOLDT AVE.	H	III	60				1
N 68	BOSTON	SHERRILL HOUSE,INC.	135 S.HUNTINGTON AVE	A,B,E,F,G (NP)	I,II,III	160				3
N 69	BOSTON	ST.JOSEPH'S MANOR	321 CENTRE ST.	1,2,3,4,5,6,7	IV (NP)	92				1
N 70	BOSTON	ST.MONICA'S HOME	17 HIGHLAND PARK ST.	A,B,C,F,G (NP)	II,III	42				1
N 71	BOSTON	STADIUM MANOR NUR.HM	461 WALNUT ST.	B	III	120				1
N 72	BOSTON	STAR OF DAVID CONVAL	1100 VFW PARKWAY	A,B,D,E,F,G,H	II,III	146				3
N 73	BOSTON	STONEHEDGE NURSING H	5 REDLANDS RD.	B,C,D,E,F,G,H	II,III	79				1
N 74	BOSTON	TOWNSEND NURSING HM	135 TOWNSEND ST.	B,E,F	III	128				1
N 75	BOSTON	TUDOR HOUSE NURS.HM.	81 S.HUNTINGTON AVE.	A,B,E,F,H	III	50				1
N 76	BOSTON	VILLAGE MANOR NUR.HM	25 ALPINE ST.	A,B,C,E,F,H	II,III	123				1
N 77	BOSTON	WEST ROXBURY MANOR	5060 WASHINGTON ST.	A,C,E,G,H	II,III	77				1
N 78	BROOKLINE	CITY VIEW NURSING HM	232 SUMMIT AVE.	A,B,C,E,F,G,H	II,III	103				1
N 79	BROOKLINE	COREY HILL NURSING H	249 COREY RD.	F	III	43				1
N 80	BROOKLINE	PARK-MARION NURSING	99 PARK ST.	A,B,C,D,E,F,G,H	II	120				2
N 81	BROOKLINE	WINTHROP RD. REST HM	24 WINTHROP RD.	1,2,3,4,5,6	IV	31				1
N 82	CAMBRIDGE	CAMBRIDGE HM.AGED	360 MT.AUBURN ST.	E	III,IV	50				3
N 83	CAMBRIDGE	CAMBRIDGE NURSING HM	1 RUSSELL ST.	A,B,C,D,E,F,G,H	II,III	119				3
N 84	CAMBRIDGE	CHESTER MANOR NURS.	10 CHESTER ST.	E,F,G,H	III	36				3
N 85	CAMBRIDGE	EXETER HOUSE NURSING	6 PRENTISS ST.	B,H	III	53				3
N 86	CAMBRIDGE	HARVARD MANOR NURS.	273 HARVARD ST.	A,B,D,E,H	III	95				3
N 87	CAMBRIDGE	MAYOR M.J.NEVILLE	650 CONCORD AVE.	B,E,F,G (NP)	II,III	155				3
N 88	CAMBRIDGE	PROSPECT ST.NURSING	195 PROSPECT ST.	A,B,E,F,G,H	II,III	100				3
N 89	CAMBRIDGE	VERNON HALL NURSING	8 DANA ST.	A,B,C,D,E,F,G,H	II,III	83				3
N 90	CHELSEA	CHELSEA JEWISH NURS.	17 LAFAYETTE AVE	A,B,G (NP)	III	60				2

TABLE 3.4b (cont.)

MEDICAL FACILITIES AND RESOURCES

NURSING HOMES

CODE	CITY	FACILTY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N 91	CHELSEA	COTTAGE MANOR NURS.	148 SHAWMUT ST.	A,E,G,H	III	34				2
N 92	DEDHAM	EASTWOOD AT DEDHAM	1007 EAST ST.	A,B,D,E,F,G,H	II,III	142				2
N 93	EVERETT	PARKWAY MANOR NUR.HM	13 SCHOOL ST.	A,B,E	III	59				2
N 94	EVERETT	WOODLAWN MANOR NURS.	289 ELM ST.	A,B,E,F,G,H	II,III	144				2
N 95	LEXINGTON	E.VILLAGE NURSING HM	140 EMERSON GARDEN R	A,B,D,E,F,G,H	I,II,III	162				3
N 96	LEXINGTON	FAIRLAWN NURSING HM	265 LOWELL ST.	A,B,E,F	III	104				1
N 97	LEXINGTON	LEXINGTON HALL CONV.	178 LOWELL ST.	A,B,E,F,H	III	100				1
N 98	LEXINTON	PINE KNOLL NURSING H	30 WATERTOWN ST.	A,B,C,E,H	I	81				2
N 99	LYNN	ABBOTT HOUSE NUR.HM.	28 ESSEX ST.	A,B,C,D,E,F,G	I	47				1
N100	LYNN	ALBA MANOR NURSING H	12 PARK ST.	B	III	34				2
N101	LYNN	ALDEN MANOR NURSING	94 FRANKLIN ST.	A,B,E	III	62				2
N102	LYNN	JOSEPH B. DEVLIN PMI	179 HOLYOKE ST.	A,B,E,F (NP)	II	54				2
N103	LYNN	LAWRENCE MANOR NURS.	26 HENRY AVE		III	39				1
N104	LYNN	LENOX HILL NUR/REHAB	70 GRANITE ST	A,B,D,E,F,G,H	I,II,III	216				2
N105	LYNN	LYNN CONV.HM.& INFIR	655 BOSTON ST.	A,B,E,G,H (NP)	III,IV	105	MASONRY	MED.	1895	2
N106	LYNN	LYNN HOME/ELDERLY P.	1 ATLANTIC TERRACE	1,2,3,4,5,6	IV (NP)	39				1
N107	LYNN	LYNN SHORE REST HOME	37 BREED ST.	1,2,3,4,5,6	IV	32				1
N108	LYNN	TWOMEY REST HOME	54 TUDOR ST.	1,2,6	IV	30				1
N109	MALDEN	BARTLETT MANOR NURS.	180 SUMMER ST.	B,G,H	III	41				1
N110	MALDEN	BUCHANAN NURSING HM	190 SUMMER ST.	F,G,H	III	35				1
N111	MALDEN	DEXTER HOUSE NURSING	120 MAIN ST.	REHAB-SP,PT,OT	I,II,III	130				2
N112	MALDEN	FORESTDALE NURSING H	342 FOREST ST.	E,F	III	69				1
N113	MALDEN	MALDEN NURSING HOME	255 CLIFTON ST.	A,E	III	53				1
N114	MALDEN	MCFADDEN MEMORIAL H.	341 FOREST ST.	A,B,E,F (NP)	III	61				1
N115	MARBLEHEAD	DEVEREUX NURSING HM	39 LAFAYETTE ST.	A,B,C,D,E,F,G,H	I,II	64				3
N116	MARBLEHEAD	LAFAYETTE CONVALSCNT	25 LAFAYETTE ST.	A,E,F,G,H	II,III	62				2
N117	MEDFORD	EMERY RETIRE/CONV.HM	34 GROVE ST.	B,E,F,G	III	32				3
N118	MEDFORD	MYSTIC MANOR	220 FOREST ST.	1,2,3,4,5,6,7	IV	32				1
N119	MEDFORD	REST HAVEN NURSING	96 MYSTIC ST.	C,D,H	III	35				3
N120	MEDFORD	WINTHROP HOUSE NURS.	300 WINTHROP ST.	A,B,D,E,F,G,H	II,III	140	MASONRY	LOW	1975	3

TABLE 3.4b (cont.)
MEDICAL FACILITIES AND RESOURCES
NURSING HOMES

CODE	CITY	FACILTY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N121	MELROSE	ELMHURST NUR/RETIRE	743 MAIN ST.	E	III	43				3
N122	MELROSE	FITCH REST HOME	75 LAKE AVE.	2,4,5,6 (NP)	IV	37				3
N123	MELROSE	KANE NURSING HOMES	15 GREEN ST.	A,B,C,D,E,F,G,H	I,III	82				3
N124	MELROSE	MIDDLESEX FELLS NURS	40 MARTIN ST.	A,B,E	I,III	106				2
N125	NAHANT	JESMOND NURSING HOME	271 NAHANT ST.	A,B,E,F	II,III	57				1
N126	NAHANT	ROCKLEDGE MANOR NURS	162 WILLOW RD.	B,E,H	III	43				1
N127	NEWTON	BRAEBURN NURSING HM	20 KINMONTH RD.	A,B,E,H	III	84	MASONRY	LOW	1962	2
N128	NEWTON	BURTON CONVALESCENT	11 WASHINGTON ST.	H	III	30	WOOD	LOW	1954	2
N129	NEWTON	CHETWYNDE NURSING HM	1650 WASHINGTON ST.	A,D,E,F,H	II,III	75	MASONRY	LOW	1967	2
N130	NEWTON	ELLIOT MANOR NURSING	25 MECHANIC ST.	A,B,G,H	III	48	WOOD	LOW	1962	1
N131	NEWTON	HEATHWOOD NURSING HM	188 FLORENCE ST.	E,H	III,IV	74	MASONRY	LOW	1971	1
N132	NEWTON	NEWTON CONVALESCENT	25 ARMORY ST.	A,B,C,D,E,F,G,H	II,III	123				2
N133	NEWTON	REGENCY HALL CONV.HM	2101 WASHINGTON ST.	A,C,D,E,F,G,H	II,III	130				2
N134	NEWTON	SWEDISH HM.-AGED	206 WALTHAM ST.	1,2,4,5,6,7	IV (NP)	30				2
N135	QUINCY	CRESTVIEW NURSING HM	86 GREENLEAF ST.	H	III	49	WOOD	LOW		3
N136	QUINCY	JOHN ADAMS NURSING	211 FRANKLIN ST.	A,F,H	II	49	WOOD	LOW		1
N137	QUINCY	PRESIDENTIAL CONVAL.	43 OLD COLONY AVE.	A,B,E,F,H	II,III	89	MASONRY	LOW	1961	3
N138	QUINCY	QUINCY NURSING HOME	11 THOMAS J.MCGRATH	A,B,C,E,F,H	II,III	139	MASONRY	LOW	1965	3
N139	QUINCY	ROBBIN HOUSE CONVAL.	205 ELM ST.	A,B,E,F,H	II,III	115	MASONRY	LOW	1964	3
N140	QUINCY	WM.B.RICE EVENTIDE	215 ADAMS ST.	B,E (NP)	III	53	MASONRY	LOW	1935	1
N141	REVERE	ANNEMARK NURSING HM	133 SALEM ST.	E	III	39				1
N142	REVERE	GERI-CARE NURSING CT	400 REVERE BEACH BLV	E,F,G,H	III	150				3
N143	SALEM	NEWHALL NURSING HOME	7 CARPENTER ST.	1,2,3,4,5,6,7	III	47				3
N144	SAUGUS	LOUISE CAROLINE NURS	266 LINCOLN AVE.	A,B,C,D,E,F,G	I,III	80				1
N145	SAUGUS	NO.SHORE CONVAL.HOME	73 CHESTNUT ST.	A,E,F,H	II,III	100				1
N146	SOMERVILLE	ADAMS NURSING HOME	26 ADAMS ST.	H	III	40				2
N147	SOMERVILLE	CLARENDON HILL NURS.	1323 BROADWAY	A,E,H	III	58				2
N148	SOMERVILLE	HM.-AGED LITTLE SIS	186 HIGHLAND AVE.	D,G (NP)	II,III,IV	120				2
N149	SOMERVILLE	PROSPECT HILL MANOR	37 MUNROE ST.	H	III	39				2
N150	SOMERVILLE	REAGAN'S RES.CARE F.	174 MORRISON AVE.	1,2,4,6,7	IV	42				1

TABLE 3.4b (cont.)

MEDICAL FACILITIES AND RESOURCES

NURSING HOMES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF CARE	LEVEL OF CARE	# BEDS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
N151	SOMERVILLE	SOMERVILLE HM./AGED	117 SUMMER ST.	1,2,3,4,5,7	IV (NP)	56				2
N152	SOMERVILLE	WINTER HILL NURSING	50 EVERGREEN AVE.		III	78				2
N153	STONEHAM	SUNSHINE NURSING HM	12 BENTON ST.	A,B,E,F,G	III	33				1
N154	SWAMPSCOTT	JEWISH REHAB.CTR.	330 PARADISE RD.	A,B,C,E,F,G,H	II,III(NP)	167				2
N155	WAKEFIELD	FOREST MANOR NURSING	8 PARKER RD.		III	39				1
N156	WAKEFIELD	GREENVIEW MANOR NURS	BATHOL ST.	A,B,D,E,F,G	II,III	106				1
N157	WAKEFIELD	GREENWOOD NURSING HM	90 GREENWOOD ST.	A,E	III	34				1
N158	WAKEFIELD	KIRKWOOD HOUSE	202 MAIN ST.	A,E,H	III	32				1
N159	WALTHAM	FOREST MANOR NURSING	50 FOREST ST.		III	44				1
N160	WALTHAM	LARCHWOOD LODGE NURS	221 WORCESTER LN.	B,H	III	32				1
N161	WALTHAM	LELAND HOME	21 NEWTON ST.	1,2,3,4,5,6,7	III,IV(NP)	41				1
N162	WALTHAM	MARISTHILL NURSING	66 NEWTON ST.	A,B,C,E,F,H	II,III(NP)	123				3
N163	WALTHAM	PIETY CORNER NURSING	325 BACON ST.	A,B,C,D,E,F,G,H	III	34				1
N164	WALTHAM	RESERVOIR NURSING HM	1841 TRAPELO RD.	A,B,E,F,G	I,II,III	120				2
N165	WALTHAM	VARNUM PARK REST HM	249 BACON ST.	1,2,3,4,5,6,7	IV	31				1
N166	WATERTOWN	CHARLESGATE MANOR	590 MAIN ST.	A,B,E,F,G	II,III	102				2
N167	WATERTOWN	EMERSON CONVALESCENT	59 COOLIDGE HILL RD.	A,B,C,D,E,F,G,H	II,III	163				3
N168	WINCHESTER	WINCHESTER CONV/NURS	223 SWANTON ST.	A,B,D,E,F,H(NP)	I,II,III	120				1
N169	WINTHROP	BAYVIEW NURSING HOME	26 STURGIS ST.	A,B,F,H	III	78				3
N170	WINTHROP	CLIFF HOUSE NURSING	170 CLIFF AVE.		II,III	90				1
N171	WINTHROP	GOVERNOR WINTHROP N.	142 PLEASANT ST.	A,B,D,E,F,G,H	II,III	87				2
N172	WOBURN	GLENDALE NURSING HM	171 CAMBRIDGE RD.	G,H	III	49				1
N173	WOBURN	WOBURN NURSING HOME	18 FRANCES ST.	A,B,C,D,E,F,G,H	II,III	110				2

KEY

TYPE OF CARE
- A = IRRIGATION & URINARY CARE
- B = CARE OF COLOSTOMY
- C = NASAL FEEDING
- D = RESIRATORY THERAPY
- E = PHYSICAL THERAPY
- F = OCCUPATIONAL THERAPY
- G = SPEECH AND HEARING THERAPY
- H = PSYCHIATRIC EVALUATION, COUNSELING

- 1 = SUPERVISION OF SELF ADMINISTERED MEDICATION
- 2 = MEDICATION AND TREATMENT BY PHYSICIAN
- 3 = RUB AND MASSAGE
- 4 = HELP WITH TUB, BATH AND SHOWER
- 5 = HELP WITH DRESSING
- 6 = HELP WITH CORRESPONDENCE AND SHOPPING
- 7 = HELP WITH WALKING

LEVEL OF CARE
- I = INTENSIVE NURSING AND REHABLITATION
- II = SKILLED NURSING CARE
- III = INTERMEDIATE CARE
- IV = REST HOME
- (NP) = NON PROFIT

TABLE 3.4c
MEDICAL FACILITIES AND RESOURCES
AMBULANCE SERVICES

CODE	CITY	FACILITY NAME	LOCATION	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACKUP POWER	TYPE OF SERVICE	# OF AMBULANCES	SEISMIC HAZARD
A 1	ARLINGTON	ARMSTRONG AMBULANCE SERVICE	12 BRATTLE COURT	MASONRY	LOW	1970'S		ALS-P	19	1
A 2	BOSTON	BOSTON HEALTH & HOSPITALS EMS	618 HARRISON AVE.					ALS-P	21,1	3
A 3	BOSTON	BREWSTER AMBULANCE SERVICE	20 BROOKLEY ROAD					BLS	15	1
A 4	BOSTON	REARDON AMBULANCE SERVICE	1684 DORCHESTER AVE.	MASONRY	LOW	1970's	YES	BLS	7,1	1
A 5	BROOKLINE	STAVIS AMBULANCE SERVICE	322 WASHINGTON ST.	MASONRY	LOW	1920's	YES	BLS	3,12	3
A 6	CAMBRIDGE	MASS.BAY PARA/MEDICAL SERVICE	180 BENT ST.					BLS	7	3
A 7	CAMBRIDGE	METRO AMBULANCE SERVICE	180 BENT ST.					BLS	10	3
A 8	MALDEN	BAY STATE AMBULANCE SERVICE	163 EASTERN AVE.	MASONRY	LOW		YES	ALS-P	38	3
A 9	MELROSE	ACTION AMBULANCE SERVICE	185 ESSEX ST.					ALS-P	14	2
A10	MILTON	FALLON AMBULANCE SERVICE	95 ELIOT ST.	MASONRY	LOW		YES	BLS	9,5	3
A11	SOMERVILLE	CATALDO AMBULANCE SERVICE	137 WASHINGTON ST.	MASONRY	LOW		NO	ALS-P	12	3
A12	WAKEFIELD	LIFELINE AMBULANCE SERVICE,INC	16 DEL CARMINE ST.	MASONRY	LOW		YES	ALS-P	12	1

KEY
TYPE OF SERVICE ALS-P = ADVANCE LIFE SUPPORT WITH PARAMEDIC
BLS = BASIC LIFE SUPPORT

TABLE 3.4d

MEDICAL FACILITIES AND RESOURCES

MEDICAL SUPPLY HOUSES

CODE	CITY	FACILITY NAME	LOCATION	TYPE	OPERATOR OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACKUP POWER	SEISMIC HAZARD
M1	MEDFORD	FISHER SCIENTIFIC CO.	461 RIVERSIDE AVE.	LAB. SUPPLIES	MR.ROBERT GIGUERE	MASONRY	LOW			3
M2	WOBURN	CURTIS MATHESON SCIENTIFIC	110 A COMMERCE WAY,BLDG.1	LAB.SUPPLIES	MR.RANDY PRATHER					1
M3	BEDFORD	AMERICAN HOSPITAL SUPPLY	20 WIGGINS AVE.	MED/SURG.SUPPLY	MR.ANDREW PITLER	MASONRY	LOW	1972	YES	3
M4	CAMBRIDGE	METROPOLITAN SUPPLY COMPANY	289 VASSAR ST.	MED/SURG.SUPPLY	MR.JEROME MYERSON	MASONRY	LOW		NO	3
M5	STONEHAM	EASTERN HOSPITAL SUPPLY	MIDDLESEX INDUSTRIAL PARK	MED/SURG.SUPPLY	MR.LORENZO DI PIPPIO	MASONRY	LOW		NO	1
M6	BOSTON	N.E.WHOLESALE DRUG CO.	879 BLUE HILL AVE.	PHARMACEUTICAL	MR.ROBERT CUDOYER	MASONRY	LOW	1973	YES	1
M7	MALDEN	JAMES BRUDNICK COMPANY, INC.	219 MEDFORD ST.	PHARMACEUTICAL	MR.RICHARD BRUDNICK					3

TABLE 3.4e

MEDICAL FACILITIES AND RESOURCES

BLOOD BANKS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	SEISMIC HAZARD
B1	BOSTON	HAHNEMANN HOSPITAL	1515 COMMONWEALTH AV	BLOOD BANK	2
B2	BOSTON	HOSPITAL AT PARKER H	53 PARKER HILL RD.	BLOOD BANK	1
B3	BOSTON	HUNTINGTON GEN'L.HOS	222 S.HUNTINGTON AVE	BLOOD BANK	3
B4	BOSTON	SIDNEY FARBER CANCER	44 BINNEY ST.	BLOOD BANK	3
B5	BOSTON	U.S.P.H.S.HOSPITAL	77 WARREN ST.	BLOOD BANK	2
B6	BROOKLINE	BROOKLINE HOSPITAL	165 CHESTNUT ST.	BLOOD BANK	1
B7	MARBLEHEAD	MARY A.ALLEY HOS.	WIDGER RD.	BLOOD BANK	3
B8	SOMERVILLE	CENTRAL HOSPITAL	26-28 CENTRAL ST.	BLOOD BANK	2
B9	DEDHAM	AMERICAN RED CROSS	180 RUSTCRAFT RD.	BLOOD BANK	3

TABLE 3.4f

MEDICAL FACILITIES AND RESOURCES

CLINICAL LABORATORIES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
C 1	ARLINGTON	HLTH.RESOURCES CORP.	792 MASS.AVE.	CLINICAL LAB				1
C 2	BEDFORD	ENVIR.SCI.ASSOCIATES	43 WIGGINS AVE.	CLINICAL LAB				3
C 3	BOSTON	AMER.RED CROSS BLOOD	812 HUNTINGTON AVE.	CLINICAL LAB	REIN. CONC.	LOW	1950's	3
C 4	BOSTON	BEACON MEDICAL LAB.	280 WASHINGTON ST.	CLINICAL LAB	STEEL	HIGH	1945	3
C 5	BOSTON	BIOBEHAVIORAL ASSAYS	85 EAST CONCORD ST.	CLINICAL LAB				3
C 6	BOSTON	BIOMEDICAL LABS.	418 WASHINGTON ST.	CLINICAL LAB	MASONRY	LOW	1963	3
C 7	BOSTON	BIORAN MEDICAL LAB.	319 LONGWOOD AVE.	CLINICAL LAB	MASONRY	MED.	1963	3
C 8	BOSTON	CHESTNUT HILL DIAG.	25 BOYLSTON ST.	CLINICAL LAB	WOOD	LOW	1893	3
C 9	BOSTON	CLIN-CHEM LABS.	1106 COMMONWEALTH	CLINICAL LAB	STEEL	MED.	1974	3
C10	BOSTON	CLINICAL MICROBIO.	35 BINNEY ST.	CLINICAL LAB	MASONRY	MED.	1962	3
C11	BOSTON	CTR. BLOOD RESEARCH	800 HUNTINGTON AVE.	CLINICAL LAB	MASONRY	LOW	1974	3
C12	BOSTON	CTR.FOR HUMAN GENE.	80 EAST CONCORD ST.	CLINICAL LAB				3
C13	BOSTON	E.BOSTON NGHBHD HTH.	10 GROVE ST.	CLINICAL LAB				3
C14	BOSTON	E.BOSTON NGHBHD.HTH.	79 PARIS ST.	CLINICAL LAB				3
C15	BOSTON	GYNECOL.,ENDOC.LAB.	80 EAST CONCORD ST.	CLINICAL LAB				3
C16	BOSTON	HORMONE RECEPTOR LAB	80 EAST CONCORD ST.	CLINICAL LAB				3
C17	BOSTON	LAB.CUTANEOUS MED.	20 PROVIDENCE ST.	CLINICAL LAB				3
C18	BOSTON	METPATH,INC.	1105 COMMONWEALTH	CLINICAL LAB				3
C19	BOSTON	NEW.ENG.NUC.ASSAY	609 ALBANY ST.	CLINICAL LAB				3
C20	BOSTON	ORAL PATHOLOGY	ONE KNEELAND ST.	CLINICAL LAB				3
C21	BOSTON	ORAL PATHOLOGY LAB.	188 LONGWOOD AVE.	CLINICAL LAB				3
C22	BOSTON	PATH.CONSULTANTS	5 EMERSON PLACE	CLINICAL LAB				3
C23	BOSTON	PEDIATRIC AMINO ACID	TWO ASH ST.	CLINICAL LAB				3
C24	BOSTON	PHYSICIANS MED.LAB.	1539 BLUE HILL AVE.	CLINICAL LAB				3
C25	BOSTON	POLY-DRUG INC.	665 BEACON ST.	CLINICAL LAB				3
C26	BOSTON	ROXBURY MEDICAL LAB.	136 WARREN ST.	CLINICAL LAB				3
C27	BOSTON	STATE LABORATORY INS	305 SOUTH ST.	CLINICAL LAB				3
C28	BOSTON	SUBURBAN MEDICAL LAB	540 VFW PARKWAY	CLINICAL LAB				1
C29	BROOKLINE	BEACON CYTOLOGY LAB.	1166 BEACON ST.	CLINICAL LAB				3
C30	BROOKLINE	COMMONWEALTH CLIN.	1166 BEAON ST.	CLINICAL LAB				3

TABLE 3.4f (cont.)

MEDICAL FACILITIES AND RESOURCES

CLINICAL LABORATORIES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
C31	BROOKLINE	HLTH.RESOURCES CORP.	830 BOYLSTON ST.	CLINICAL LAB				3
C32	BROOKLINE	MEDICALAB INC.	1180 BEACON ST.	CLINICAL LAB				3
C33	BROOKLINE	SMITH KLINE CLIN.LAB	1093 BEACON ST.	CLINICAL LAB				3
C34	CAMBRIDGE	BIORAN MEDICAL LAB.	415 MASS.AVE.	CLINICAL LAB				3
C35	CAMBRIDGE	BIORAN MEDICAL LAB.	575 MT.AUBURN ST.	CLINICAL LAB				3
C36	CAMBRIDGE	CAMBRIDGE DIAGNOSTIC	359 ALLSTON ST.	CLINICAL LAB				3
C37	CAMBRIDGE	GEORGE W. BOYLEN JR.	77 MASSACHUSETTS AVE	CLINICAL LAB				3
C38	CAMBRIDGE	HARVARD COMMUN.HTH.	63 ROGERS ST.	CLINICAL LAB				3
C39	LEXINGTON	LEXINGTON MED.LAB.	16 CLARKE ST.	CLINICAL LAB				2
C40	LEXINGTON	NATIONAL LABS	114 WALTHAM ST.	CLINICAL LAB				2
C41	LYNN	LAB.FOR CLINICAL MED	225 BOSTON ST.	CLINICAL LAB	MASONRY	LOW		1
C42	MALDEN	FAULKNER MED.LAB.	410 FERRY ST.	CLINICAL LAB				3
C43	MALDEN	MALDEN MEDICAL LAB.	388 PLEASANT ST.	CLINICAL LAB				3
C44	MALDEN	MEDIC CLINICAL LAB.	271 SALEM ST.	CLINICAL LAB				1
C45	MEDFORD	MEDFORD MEDICAL LAB.	28 HIGH ST.	CLINICAL LAB				3
C46	MELROSE	MELROSE MEDICAL LAB.	401 MAIN ST.	CLINICAL LAB				2
C47	MILTON	MILTON MEDICAL LAB.	75 ADAMS ST.	CLINICAL LAB				1
C48	NEWTON	LAB.STONE RESEARCH	81 WYMAN ST.	CLINICAL LAB	MASONRY	LOW	1959	2
C49	QUINCY	FURNACE BROOK MED.	1261 FURNACE BROOK	CLINICAL LAB	REIN. CONC.	LOW	1968	1
C50	QUINCY	S.SHORE PATHOLOGY	67 CODDINGTON ST.	CLINICAL LAB	MASONRY	LOW	1949	3
C51	REVERE	SPECTRUM MEDICAL LAB	209 SQUIRE RD.	CLINICAL LAB				3
C52	SALEM	SALEM MEDICAL LAB.	393 ESSEX ST.	CLINICAL LAB				3
C53	SOMERVILLE	BIORAN MEDICAL LAB.	30 CROCKER ST.	CLINICAL LAB				2
C54	STONEHAM	STONEHAM MEDICAL LAB	272 MAIN ST.	CLINICAL LAB				1
C55	SWAMPSCOTT	POLY-MEDICAL LAB.	990 PARADISE RD.	CLINICAL LAB				2
C56	WAKEFIELD	NOREEN MCMANUS CLIN.	29 TUTTLE ST.	CLINICAL LAB				2
C57	WALTHAM	BOSTON MEDICAL LAB.	15 LUNDA ST.	CLINICAL LAB				1
C58	WALTHAM	SMITH KLINE CLIN.LAB	343 WINTER ST.	CLINICAL LAB				1
C59	WINCHESTER	WINCHESTER MED.LAB.	28 CHURCH ST.	CLINICAL LAB				1
C60	WOBURN	NEW ENG.PATHOLOGY	10 N.ROESSLER RD.	CLINICAL LAB				1

TABLE 3.4g
MEDICAL FACILITIES AND RESOURCES
HEALTH MANPOWER DISTRIBUTION

CITY	PHYSCIANS (1988)	REGISTERED NURSES (1977)	TOTAL
ARLINGTON	122	201	323
BEDFORD	69	219	288
BELMONT	229	205	434
BOSTON	5,901	8,921	14,822
BROOKLINE	728	332	1060
CAMBRIDGE	844	893	1,737
CHELSEA	42	120	162
DEDHAM	70	35	105
EVERETT	54	188	242
LEXINGTON	128	136	264
LYNN	182	632	814
MALDEN	90	349	439
MARBLEHEAD	50	85	135
MEDFORD	153	236	389
MELROSE	94	332	426
MILTON	108	137	245
NAHANT	2	16	18
NEWTON	540	633	1,173
QUINCY	180	554	734
REVERE	34	74	108
SALEM	171	554	725
SAUGUS	8	70	78
SOMERVILLE	90	231	321
STONEHAM	86	282	368
SWAMPSCOTT	52	17	69
WAKEFIELD	37	77	114
WALTHAM	184	534	718
WATERTOWN	87	77	164
WINCHESTER	108	19	127
WINTHROP	36	66	102
WOBURN	69	252	321
*** Total ***			
	10,548	16,477	27,025

TABLE 3.4h
MEDICAL FACILITIES AND RESOURCES
ENGINEERING STRUCTURE CLASSIFICATION

FACILITY	# SAMPLED / TOTAL #	ENGINEERING STRUCTURE CLASSIFICATION											
		1	2	3	4	5	6	7	8	9	10	11	12
HOSPITALS	12 / 55			25%	58%				17%				
NURSING HOMES	26 / 173	35%		46%	15%		4%						
AMBULANCE SERVICES	7 / 12			100%									
MEDICAL SUPPLY HOUSES	5 / 7			100%									
BLOOD BANKS	0 / 9			25%	58%				17%				
CLINICAL LABS	12 / 60	8%		42%	17%		17%					8%	8%

TABLE 3.4i
MEDICAL FACILITIES AND RESOURCES
REPLACEMENT VALUES ($-THOUSANDS)
BY CELLS AND ZONES

FACILITY	CELLS / ZONES	1-9	1	1-3	2-3	4	4-5	4,6	5	5,7	6	7	8	8-9	6,8,9	9
HOSPITALS	1			118,860				109,515		72,313				112,007		
	2			24,787				37,247		30,261				-		
	3			-				20,248		243,282				24,742		
NURSING HOMES	1		12,376		13,701	15,211			12,243		13,171	28,302	17,835			44,626
	2		18,550		5,724	10,044			26,209		40,969	3,180	3,763			2,332
	3		1,696		4,293	11,528			20,829		7,579	20,882	3,869			27,216
AMBULANCE SERVICES	1	1,350														
	2	350														
	3	2,950														
MEDICAL SUPPLY HOUSES	1	2,322														
	2	-														
	3	3,096														
BLOOD BANKS	1	1,130														
	2	1,695														
	3	2,260														
CLINICAL LABS	1			1,968			1,968					-			1,476	
	2			1,968			984					-			492	
	3			984			1,968					15,736			1,968	

3.5 Transportation Facilities and Systems

3.5.1 Overview. Transportation facilities include highway systems, airports, water ports, and public transit. Following is an overview of each of these facilities.

Highways: The major highways serving Massachusetts radiate from Boston and vicinity like the spokes of a wheel, with two highways linking the spokes. Boston serves as the hub of the area, with a combination of multilane toll roads, state routes, and U.S. interstate routes serving as the spokes radiating out to route 128. Route 128 bounds the study area. The highway interchanges for these routes are listed in Table 3.5a. The highway transportation system of downtown Boston consists of elevated structures in the most heavily traveled areas and bridges and tunnels connecting Boston to the remainder of the area across the Charles and Mystic rivers. These tunnels are detailed in Table 3.5b, and the bridges are detailed in Table 3.5c.

Airports: Boston's Logan International Airport, owned and operated by the Massachusetts Port Authority (Massport), is located on Governor's Island, across the inner harbor, approximately 2 miles from Boston's central business district. Logan International is the 13th busiest airport in the world in terms of passenger traffic, offering more than 400 international flights weekly and 700 domestic flights daily. Some 40 commercial and charter carriers serve the airport.

Recognized as one of the United States' fastest-growing airports, Logan International is ranked sixth out of the United States gateway airports in terms of value and volume of import and export air freight.

The airport has eight runways and services seven terminals. A large multilevel garage structure serves as the center of the facility, with an old and new control tower adjacent to it. The seven ter-

minals branch out from the garage and towers. other critical facilities include the Massport pumping stations, heating plant, and maintenance center. Emergency facilities include a fire and crash station, as well as a fire mooring for water emergencies, since airport runway approaches are over water.

The L. G. Hanscom Airport in Bedford serves both the military and the public. A portion of this airport is owned and operated by Massport, the rest by the U.S. Air Force. Hanscom has two runways and one terminal building. Major facilities include the air traffic control tower, the terminal buildings, fuel pumps and storage (above and below ground). Also included are a Massport hangar and maintenance center.

The Boston heliport, located on Nashua Street, provides helicopter landing, service and storage facilities, and helicopter commuter service from the downtown area to Logan International Airport.

Table 3.5d is a listing of the airports, and Table 3.5e details the airport facilities. The airports have backup power for the airfields, control towers, and terminals.

Water Ports: Massport owns or leases the properties at the Port of Boston. These properties include a full-service port with tug and towboat service, as well as commercial, private, and military marine terminals with repair facilities for construction and conversion of oceangoing vessels and barges. This port is the central hub for the New England States. Two railroads, the Boston and Maine (B&M) and Conrail, provide trackage to the dockside. The area is also serviced by more than 200 common carrier truck lines transporting containerized goods to various destinations. There are 114 piers and wharves (of varying capacities and capabilities), with most of the berthing accommodations located on the main channel at East Boston, Charlestown, Mystic River, South Boston, Chelsea River, and Chelsea Water-

front. All of the deep-draught facilities have direct highway connections, and most have railroad connections. Water and electrical shore power are available at most piers and wharves. All grades of heavy marine bunker fuel, lubricants, and diesel fuel are available either directly at marine oil terminals or by barges at anchor or loading berths. A 60-ton floating derrick, crawler, and mobile cranes up to 150 tons are available for heavy lifting at shipside throughout the harbor.

The port is divided into seven areas: South Boston, Downtown Boston (no cargo facilities), Charlestown, Everett, Chelsea, Revere, and East Boston. Some special facilities include the following:

- The East Boston facilities include two floating drydocks. One has a lifting capacity of 18,000 tons, two 35-foot aprons, and one 20-ton and two 25-ton gantry cranes. The other has two 15-ton gantry cranes, a granny dock, and a 60-ton mobile crane.

- In Quincy, the shipbuilding yard operated by General Dynamics constructs and services the U.S. Navy's military Sealift Command and nuclear submarines. Quincy has five graving/shipbuilding docks with one 1,200-ton overhead traveling bridge crane and one 100-ton, two 75-ton, and four 50-ton gantry cranes.

Several petroleum and oil companies have seaport facilities to receive and ship various petroleum products. In most facilities, pipelines extend from the wharves to storage tanks.

Table 3.5f details the inventory for water port facilities.

Public Transit: The Massachusetts Bay Transportation Authority (MBTA) operates two transportation systems in the study area: the commuter rail service and the rapid transit service.

MBTA owns and controls operations for eleven commuter rail service lines totaling over 250 miles of track. After purchasing the lines

in 1976, MBTA awarded two successive five-year contracts to the Boston and Maine Railroad to operate these lines. The most recent contract was awarded to Amtrak. The commuter rail service is centered around downtown Boston at the North and South stations and provides service for eastern Massachusetts.

Four routes comprise the North Side service in the study area:

- Eastern Route -- service to Cell 1
- Merrimack Valley Route -- service to Cell 2
- New Hampshire Route -- service to Cell 3
- Fitchburg Route -- service to Cell 4

An additional five routes comprise the South Side service in the study area. These routes run through Cells 6, 7, 8, and 9, providing service terminating outside the study area. The commuter rail lines serve a total of 92 stations, 34 of which are in the study area.

Rapid transit service consists of three rapid rail lines (the Blue, Orange, and Red lines) and one "light rail" line or streetcar (the Green Line).

The Blue Line operates between Bowdoin Square Station in downtown Boston and Wonderland Station in Revere. The Orange Line operates between Oak Grove Station in Malden and Forest Hills Station in Jamaica Plain, through downtown Boston. The Red Line operates between Alewife Station in Cambridge and Ashmont Station in Dorchester, through downtown Boston. A branch route operates between Alewife Station and Braintree via downtown Boston and Quincy. An extension of the Red Line is operated by "light rail" cars from Ashmont to Mattapan Station. All three lines run on the surface and as subways, and all of them have car yards and repair shops associated with them.

The Green Line operates between downtown Boston and several destinations to the west and southwest of the city. The portion from Park Street Station to just west of Boylston Street Station was opened September 1, 1897, and was the first subway in America. This original section is listed on the National Register of Historic Places.

The Green Line has five routes serving the Boston Area (Route A through Route E) although one route (Route A) is not currently operational. This streetcar service operates on the surface and as a subway. The cars are stored at Mattapan Station.

Table 3.5g details public transit agencies, Table 3.5h provides public transit statistics, and Table 3.5i lists the rapid transit rail lines.

3.5.2 Engineering Classifications and Replacement Values. Replacement values for all highway-associated transportation facilities are detailed by engineering structure classification, cells, and seismic hazard zones in Table 3.5k.

Replacement values for airports include only publicly owned facilities. Private airline hangars and administration offices were not included. Replacement values for all airport facilities are detailed by engineering structural classification, cells, and seismic zones in Table 3.5l.

Replacement values for water ports are detailed by engineering structure classification, cells, and seismic zones in Table 3.5m.

Engineering structure classifications for both garages and terminals as well as surface or elevated rapid transit stations were assigned an assumed engineering structure classification of low-rise masonry (40%), low-rise steel reinforced concrete (40%), and low-rise steel (20%).

Replacement values for all rapid transit facilities are detailed by engineering structure classification, cells, and seismic hazard zones in Table 3.5n.

TABLE 3.5a

TRANSPORTATION FACILITIES AND SYSTEMS

HIGHWAY INTERCHANGES

CODE	CITY	INTERSTATE #	STATE ROUTE #	U.S. ROUTE #	SEISMIC HAZARD
I 1	BEDFORD			US3	1
I 2	BOSTON	193	SR3		3
I 3	BOSTON	193	SR3		3
I 4	BOSTON	193	SR3		3
I 5	BOSTON	190			3
I 6	BOSTON	193	SR3		3
I 7	BOSTON	190			3
I 8	BOSTON	193	SR3		3
I 9	BOSTON	190			3
I10	BOSTON	193	SR3,3A,203		3
I11	BOSTON	190			3
I12	MILTON	193	SR3		3
I13	BOSTON	190	SR9		3
I14	BOSTON	190	SR28		3
I15	BOSTON	190,93	SR3		3
I16	DEDHAM	195	SR128,135		1
I17	DEDHAM	195	SR128		1
I18	DEDHAM	195	SR1A,128	US1	1
I19	DEDHAM	195			3
I20	LEXINGTON	195			3
I21	LEXINGTON	195	SR2A,128		1
I22	LEXINGTON	195	SR2,128		1
I23	MEDFORD	193			3
I24	MEDFORD	193	SR16		3
I25	MEDFORD	195	SR16		3
I26	MEDFORD	193			3
I27	MEDFORD	193	SR28		3
I28	MILTON	193	SR3		1
I29	NEWTON	190	SR16		3
I30	NEWTON	190			3

TABLE 3.5a (cont.)
TRANSPORTATION FACILITIES AND SYSTEMS
HIGHWAY INTERCHANGES

CODE	CITY	INTERSTATE #	STATE ROUTE #	U.S. ROUTE #	SEISMIC HAZARD
131	NEWTON	190			3
132	NEWTON		SR30		3
133	NEWTON	195			3
134	NEWTON	195	SR128		2
135	NEWTON		SR16,128		2
136	QUINCY	193	SR3		1
137	QUINCY	193	SR3		1
138	QUINCY		SR3		1
139	SOMERVILLE	193	SR28		3
140	STONEHAM	193	SR28		3
141	STONEHAM	193			1
142	WAKEFIELD		SR128		2
143	WAKEFIELD		SR128		3
144	WAKEFIELD		SR128		3
145	WALTHAM	195	SR128		1
146	WALTHAM	195	SR128		1
147	WALTHAM	195		US20	3
148	WOBURN	193			3
149	WOBURN	193			1
150	WOBURN		SR128		1
151	WOBURN	195	SR38		3

TABLE 3.5b

TRANSPORTATION FACILITIES AND SYSTEMS

TUNNELS

CODE	FACILITY NAME	LOCATION	LENGTH (FEET)	SEISMIC HAZARD
T1	SUMNER TUNNEL	BOSTON INNER HARBOR	5,000	3
T2	CALLAHAN TUNNEL	BOSTON INNER HARBOR	5,000	3
T3	MBTA TUNNEL	BOSTON INNER HARBOR	4,500	3

TABLE 3.5c

TRANSPORTATION FACILITIES AND SYSTEMS

BRIDGES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF BRIDGE	SPAN (FEET)	BRIDGE SERVICE	SEISMIC HAZARD
B 1	BOSTON	CHARLESTON BRIDGE	MAIN ST. - WASHINGTON ST.	FIXED	700'	ROAD	3
B 2	QUINCY	BASCULE BRIDGE.	WASHINGTON ST.		600'	ROAD	3
B 3	BOSTON	NORTHERN AVE BRIDGE	NORTHERN AVE.	SWING	600'	ROAD	3
B 4	BOSTON	CONGRESS ST.BRIDGE	CONGRESS ST.	FIXED	500'	ROAD	3
B 5	BOSTON	SUMMER ST.BRIDGE	SUMMER ST.	FIXED	500'	ROAD	3
B 6	BOSTON	SUMMER ST.BRIDGE	SUMMER ST.	RETRACTIBLE	500'	ROAD	3
B 7	BOSTON	MYSTIC R-TOBIN MEMORIAL B	NORTHEASTERN EXPRESSWAY	FIXED,DBL.DECK	1200'	ROAD	3
B 8	BOSTON	MALDEN BASCULE BRIDGE	ALFORD-BROADWAY		800'	RAIL & ROAD	3
B 9	SOMERVILLE	WELLINGTON BRIDGE	NORTHERN ARTERY		700'	ROAD	3
B10	BOSTON	BASCULE BRIDGE	EASTERN-CHELSEA		900'	ROAD	3
B11	BOSTON	CHARLES RIVER DAM	MSGR.O'BRIEN HIGHWAY		1400'	ROAD	3
B12	BOSTON	LONGFELLOW BRIDGE	MAIN ST. - CAMBRIDGE ST.		2000'	RAIL & ROAD	3
B13	BOSTON	HARVARD BRIDGE	MASSACHUSETTS AVE.		2000'	ROAD	3
B14	BOSTON	BOSTON UNIV.BRIDGE	ESSEX ST.		400'	RAIL & ROAD	3
B15	BOSTON	RIVER ST.BRIDGE	CAMBRIDGE-RIVER		250'	ROAD	3
B16	BOSTON	WESTERN AVE.BRIDGE	WESTERN AVE. BRIDGE		400'	ROAD	3
B17	BOSTON	LARZ ANDERSON BRIDGE	N.HARVARD ST.-J.F.K. ST.		400'	ROAD	3
B18	BOSTON	CHARLESTOWN BRIDGE	MAIN ST. - WASHINGTON ST.	RAILROAD BRIDGE	1000'	RAIL & ROAD	3
B19	BOSTON	NORTHEASTERN EXPRESSWAY	NORTHEASTERN EXPRESSWAY	FIXED	300'	ROAD	3
B20	BOSTON		HANCOCK ST.		700'	ROAD	3
B21	BOSTON		SOUTHEAST EXPRESSWAY		500	ROAD	3
B22	REVERE	GENERAL EDWARDS BRIDGE	STATEROUTE 1A		1300'	ROAD	3
B23	LYNN	BUCHANAN BRIDGE	STATEROUTE 107		220'	ROAD	1

TABLE 3.5d

TRANSPORTATION FACILITIES AND SYSTEMS

AIRPORTS

CODE	CITY	AIRPORT NAME	LOCATION	TYPE OF FACILITY	RUNWAY #	RUNWAY LENGTH	BACK UP POWER	HAZARD CAPABILITIES	SEISMIC HAZARD
A1	BOSTON	BOSTON-LOGAN	BOSTON	PUBLIC	4R	7,494ft.	YES	YES	3
					4L	7,860ft.			
					9-27	7,000ft.			
					33L	10,081ft.			
					15L-33R	2,470ft.			
					22L	8,801ft.			
					22R	7,032ft.			
					15R	9,199ft.			
A2	BOSTON	BOSTON HELIPORT	NASHUA ST.	PUBLIC	PAD	95x100ft.			3
A3	BEDFORD	L.G.HANSCOM	BEDFORD	PUBLIC	11-19	7,000ft	YES		3
					5-23	5,000ft.			

TABLE 3.5e

TRANSPORTATION FACILITIES AND SYSTEMS

AIRPORT FACILITIES

CODE	CITY	AIRPORT NAME	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	HAZARDOUS MATERIALS SITE	SEISMIC HAZARD
F 1	BOSTON	BOSTON LOGAN	M.P.A. PUMPING STATION			YES	3
F 2	BOSTON	BOSTON LOGAN	OLD CONTROL TOWER	STEEL	MED.	NO	3
F 3	BOSTON	BOSTON LOGAN	NEW CONTROL TOWER	REIN. CONC.	HIGH	NO	3
F 4	BOSTON	BOSTON LOGAN	FIRE AND CRASH STATION			NO	3
F 5	BOSTON	BOSTON LOGAN	FIRE BOAT MOORING			NO	3
F 6	BEDFORD	L.G. HANSCOM	AIR TRAFFIC CONTROL TOWER			NO	3
F 7	BEDFORD	L.G. HANSCOM	FUEL PUMPS and STORAGE			YES	1
F 8	BEDFORD	L.G. HANSCOM	FUEL STORAGE (above ground)			YES	3
F 9	BOSTON	BOSTON LOGAN	INTERNATIONAL TERMINAL	REIN. CONC.	LOW	NO	3
F10	BOSTON	BOSTON LOGAN	PIER-A	REIN. CONC.	LOW	NO	3
F11	BOSTON	BOSTON LOGAN	PIER-B	REIN. CONC.	LOW	NO	3
F12	BOSTON	BOSTON LOGAN	NORTH TERMINAL	REIN. CONC.	LOW	NO	3
F13	BOSTON	BOSTON LOGAN	PIER-C	REIN. CONC.	LOW	NO	3
F14	BOSTON	BOSTON LOGAN	SOUTH TERMINAL	REIN. CONC.	LOW	NO	3
F15	BOSTON	BOSTON LOGAN	EASTERN AIR TERMINAL	REIN. CONC.	LOW	NO	3
F16	BOSTON	BOSTON LOGAN	MULTI-LEVEL GARAGE	REIN. CONC.	MED.	NO	3
F17	BOSTON	BOSTON LOGAN	M.P.A. FIELD MAINTENANCE CTR.			NO	3
F18	BOSTON	BOSTON LOGAN	M.P.A. HEATING PLANT			NO	3
F19	BEDFORD	L.G. HANSON	TERMINAL BLDG. (CIVIL)		LOW	NO	3
F20	BEDFORD	L.G. HANSON	M.P.A. HANGER NO. 2			NO	3
F21	BEDFORD	L.G. HANSON	MAINTENANCE BLDG. (M.P.A.)			NO	3

KEY M.P.A. = MASSACHUSETTS PORT AUTHORITY

TABLE 3.5f

TRANSPORTATION FACILITIES AND SYSTEMS

WATER PORTS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	LENGTH OF DOCK FACE	# DOCKS	# CRANES	PIPELINE	HAZARDOUS MATERIALS HANDLED	SEISMIC HAZARD
D 1	BOSTON	AMSTAR SUGAR CO.	425 MEDFORD ST.	AMERICAN SUGAR CO.	371'	1	1	YES		3
D 2	BOSTON	ATLANTIC CEMENT CO.	285 MEDFORD ST.	ATLANTIC CEMENT CO.	103'	1	0	YES		3
D 3	BOSTON	BETHLEHEM STEEL	256 MARGINAL ST	BETHLEHEM STEEL CORP	100'	5	2	NO		3
D 4	BOSTON	BOSTON ARMY BASE	666 SUMMER ST.S	PORT TERMINALS, INC.	9000'	1	2	NO		3
D 5	BOSTON	BOSTON FISH PIER	99 HIGH ST.	MASSPORT AUTHORITY	300'	1	0	NO		3
D 6	BOSTON	BOSTON FUEL TRANSP.	36 NEW STREET		600'	0	0	NO	PETROLEUM PROD.	3
D 7	BOSTON	BOSTON SHIPYARD CORP	256 MARGINAL ST	BILL KENNWEDY	1000'	5	5	NO		3
D 8	BOSTON	BOSTON TOWBOAT CORP.	404 BORDER ST.	BOSTON TOWBOAT CORP.	600'	0	0	NO		3
D 9	BOSTON	COMMONWEALTH PIER	99 HIGH ST.	MASS. PORT AUTHORITY	400'	1	0	NO		3
D10	BOSTON	GENERAL SHIP CORP.	400 BORDER ST.	GENERAL SHIP CORP.	1000'	3	4	NO		3
D11	BOSTON	HOOSAC PIER		MASSPORT AUTHORITY	1000'	1	0	NO		3
D12	BOSTON	INDIA WHARF	BOSTON		300'	0	0	NO		3
D13	CHELSEA	QUINOIL	MARGINAL ST.	QUINOIL	1000'	1	0	YES	OIL	3
D14	BOSTON	MASSPORT FIREBOAT	EAST BOSTON		600'	0	0	NO		3
D15	BOSTON	MASSPORT MARINE TER.	SOUTH BOSTON	MASSPORT AUTHORITY	2700'	1	5	NO		3
D16	BOSTON	MDC HARBOR PATROL	154 BERKELEY	M.D.C.	1200'	1	0	NO		3
D17	BOSTON	MOBIL OIL CORP	445 CHELSEA ST.	MOBIL OIL	400'	1	0	YES	GASOLINE, OIL	3
D18	BOSTON	MORAN CONTAINER TERM	TERMINAL ST.	MASSPORT AUTHORITY	1100'	1	7	NO		3
D19	BOSTON	MYSTIC PIER #1	99 HIGH ST.	MASSPORT AUTHORITY	458'	1	0	NO		3
D20	BOSTON	McKIE COMPANY	954 HINGHAM ST.	McKIE COMPANY	1000'	0	1	NO	CHEMICALS	3
D21	BOSTON	P.W. CONLEY TERMINAL	99 HIGH ST.	MASS. PORT AUTHORITY	1000'	1	2	NO	PETROLEUM PROD.	3
D22	BOSTON	PIER 50	HIGH ST.		3000'	1	0	NO		3
D23	BOSTON	REVERE SUGAR CO.	333 MEDFORD ST.	REVERE SUGAR CO	800'	1	0	NO		3
D24	BOSTON	SCHIAVONE SCRAP TERM	MORAN TERMINAL	SCHIAVONE & SONS	700'	1	3	NO		3
D25	BOSTON	SEA-LAND SERVICE	200 FRONTAGE RD	CASTLE ISLAND	600'	1	1	NO		3
D26	BOSTON	SOUTH & EAST JETTY	660 SUMMER ST.	CITY OF BOSTON	1200'	1	0	NO		3
D27	BOSTON	TEXACO, INC.	900 EAST FIRST	TEXACO, INC.	84'	2	0	YES	AVJET,OILS	3
D28	BOSTON	TOYOTA	CASTLE ISLAND	TOYOTA MOTORS	1000'	1	0	NO		3
D29	BOSTON	U.S. GYPSUM	MORAN TERMINAL	U.S. GYPSUM	600'	1	1	NO		3
D30	BOSTON	U.S.COAST GUARD BASE	COMMERCIAL ST.	U.S.DEPT.OF INTERIOR	1000'	1	0	NO		3

TABLE 3.5f (cont.)

TRANSPORTATION FACILITIES AND SYSTEMS

WATER PORTS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	LENGTH OF DOCK FACE	# DOCKS	# CRANES	PIPELINE	HAZARDOUS MATERIALS HANDLED	SEISMIC HAZARD
D31	CHELSEA	AMERICAN OIL	295 EASTERN AVE	AMERICAN OIL	600'	1	0	YES	GAS, KEROSENE, OIL	3
D32	CHELSEA	GULF OIL	123 EASTERN AVE	GULF OIL	60'	1	0	YES	OIL,GAS, FUEL	3
D33	CHELSEA	MUNRO DRYDOCK			600'	0	0	NO		3
D34	CHELSEA	ULTRAMAR	11 BROADWAY	ULTRAMAR	100'	1	0	YES	OIL	3
D35	CHELSEA	TEXACO, INC.	99 MARGINAL ST.	TEXACO, INC.	60'	1	0	YES	GASOLINE,DEISEL OIL	3
D36	CHELSEA	PITTSTON PETROLEUM	11 BROADWAY	PITTSTON PETROLEUM	300'	0	1	NO	HEATING OIL 6 OIL	3
D37	EVERETT	ALLIED CONCRETE			300'	0	0	NO		3
D38	EVERETT	BELCHER NEW ENGLAND		BELCHER NEW ENGLAND	600'	0	1	NO	OIL	3
D39	EVERETT	COLDWATER SEAFOOD	60 COMMERCIAL	COLDWATER SEAFOOD	362'	1	0	NO		3
D40	EVERETT	DISTRIGAS OF MASS.	18 ROVER ST.	DISTRIGAS OF MASS.	267'	1	5	YES	LIQUIFIED GAS	3
D41	EVERETT	EXXON COM.,U.S.A.	30 BEACHAM ST.	EXXON COMPANY,U.S.A.	265'	0	0	YES	CHEMICALS,FUEL,OILS, KEROSENE	3
D42	EVERETT	PROLERIZED NEW ENG.	ROVER ST.	PROLERIZED NEW ENG.	320'	1	2	NO		3
D43	QUINCY	C.H.SPRAUGE & SONS	SPRAUGUE TERM.	SPRAUGUE & SONS	600'	1	0	NO	FUEL,OIL	3
D44	QUINCY	GENERAL DYNAMICS	97 HOWARD ST.	GENERAL DYNAMICS	400'	1	0	NO		3
D45	QUINCY	MOBIL OIL	740 WASHINGTON	MOBIL OIL	90'	1	0	NO	GASOLINE,OIL	3
D46	QUINCY	PROCTOR & GAMBLE		PROCTOR & GAMBLE	150'	1	0	NO	OILS	3
D47	QUINCY	QUINOIL INDUSTRIES	10 McGRATH HWY.	QUINOIL INDUSTRIES	100'	1	0	NO	OIL	3
D48	REVERE	BELCHER NEW ENGLAND	222 LEE BURBANK	BELCHER NEW ENGLAND	500'	1	1	YES	ALCOHOL,HEATING OIL OIL,NO. 6	3
D49	REVERE	GIBBS OIL	40 LEE BURBANK	GIBBS OIL	300'	1	0	YES	GASOLINE,OIL	3
D50	CHELSEA	JENNY OIL	MARGINAL ST.	JENNY OIL	400'	1	0	NO	GASOLINE	3

TABLE 3.5g

TRANSPORTATION FACILITIES AND SYSTEMS

PUBLIC TRANSIT AGENCIES

CITY	PUBLIC BUS	RAPID RAIL	PASSENGER RAIL	PRIVATE BUS
ARLINGTON	MBTA			
BEDFORD	MBTA			BCS
BELMONT	MBTA		AMTRAK	
BOSTON	BAT,MBTA,MPA	MBTA(RED, BLUE, ORANGE, AND GREEN LINES)	AMTRAK	AL,BBL,ECL GLI,HBL,IC HUB,MT,PBS PP,RTI,TMC SS,VTL
BROOKLINE	MBTA	MBTA (GREEN LINE)		
CAMBRIDGE	MBTA	MBTA (GREEN LINE & RED LINE)	AMTRAK	HUB
CHELSEA	MBTA			
DEDHAM	MBTA		AMTRAK	HBL
EVERETT	MBTA			
LEXINGTON	MBTA			
LYNN	MBTA		AMTRAK	
MALDEN	MBTA	MBTA (ORANGE LINE)		
MARBLEHEAD	MBTA			
MEDFORD	MBTA	MBTA (ORANGE LINE)	AMTRAK	HBL
MELROSE	MBTA		AMTRAK	
MILTON	BAT,MBTA	MBTA (RED LINE)		BHT,PBS
NAHANT	MBTA			
NEWTON	MBTA	MBTA (GREEN LINE)	AMTRAK	
QUINCY	MBTA	MBTA (RED LINE)		IC
REVERE	MBTA	MBTA (BLUE LINE)		
SALEM	MBTA		AMTRAK	MT
SAUGUS	MBTA			
SOMERVILLE	MBTA			
STONEHAM	MBTA			HBL
SWAMPSCOTT	MBTA		AMTRAK	

TABLE 3.5g (cont.)

TRANSPORTATION FACILITIES AND SYSTEMS

PUBLIC TRANSIT AGENCIES

CITY	PUBLIC BUS	RAPID RAIL	PASSENGER RAIL	PRIVATE BUS
WAKEFIELD	MBTA		AMTRAK	
WALTHAM	MBTA		AMTRAK	
WATERTOWN	MBTA			
WINCHESTER	MBTA		AMTRAK	
WINTHROP			RTI	
WOBURN	MBTA			

KEY

MBTA = MASSACHUSETTS BAY TRANSPORTATION AUTHORITY
BAT = BROCKTON AREA TRANSPORTATION AUTHORITY
MPA = MASSACHUSETTS PORT AUTHORITY
BCS = BEDFORD CHARTER SERVICE
AL = ARROW LINES, INC.
BBL = BONANZA BUS LINES, INC.
ECL = ENGLANDER COACH LINES, INC.
GLI = GRAY LINE, INC.
HBL = HUDSON BUS LINES, INC.
IC = INTERSTATE COACH, UNDA'S BUS
HUB = HUB BUS LINES
MT = MICHAUD TRAILWAYS, INC.
PBS = PLYMOUTH & BROCKTON STREET RAILWAY COMPANY
RTI = RAPID TRANSIT, INC.
TMC = TROMBLY MOTOR COACH SERVICE, INC.
SS = STEPHAN - SUBURBAN CORPORATION
VTL = VERMONT TRANSIT LINES
BHT = BRUSH HILL TRANSPORTATION COMPANY

TABLE 3.5h

TRANSPORTATION FACILITIES AND SYSTEMS

PUBLIC TRANSIST STATISTICS

TRANSPORT METHOD	# ROUTES*	# VEHICLES*	# STATIONS*	# OF STATIONS IN STUDY AREA
BUS	152	987	0	0
LIGHT RAIL (GREEN LINE)	5	290	32	32
RAPID TRANSIT (BLUE-ORANGE-RED LINES)	3	411	49	49
TRACKLESS TROLLEY	4	50	0	0
COMMUTER RAIL	9	293	92	34

* Statistics are for MBTA district which includes 79 communities

TABLE 3.5i

TRANSPORTATION FACILITIES AND SYSTEMS

RAPID TRANSIT RAIL LINES

RAPID RAIL LINE	SURFACE MILES (ONE WAY)	SUBWAY MILES (ONE WAY)	TOTAL MILES (ONE WAY)	TOTAL # OF STATIONS	SURFACE STATIONS	SUBWAY STATIONS	ELEVATED STATIONS
BLUE	4.3	1.6	5.9	12	7	5	-
ORANGE	9.3	1.5	10.8	19	13	6	-
RED							
(Alewife-Braintree)	8.5	9.1	17.6	17	5	12	-
(Alewife-Ashmont)	8.5	3.2	11.7	17	5	12	-
GREEN							
Ashmont-Mattapan	2.5	0	2.5	8	8	-	-
B Line-Boston College	5.5	2.5	8.0	12	2	8	2
C Line-Cleveland Circle	4.1	2.5	6.6	12	2	8	2
D Line-Riverside	2.4	9.8	12.2	22	13	8	1
E Line-Arbourway	1.8	3.7	5.5	10	4	6	-

TABLE 3.5j

TRANSPORTATION FACILITIES AND SYSTEMS

PUBLIC TRANSIT GARAGES AND TERMINALS

CODE	CITY	FACILITY NAME	TYPE OF FACILITY	LOCATION	YEAR BUILT	STORAGE CAPACITY	REPAIR CAPACITY	VEHICLE TYPE	BACKUP POWER	SEISMIC HAZARD
G 1	BOSTON	ARBORWAY YARD	GARAGE	3570 WASHINGTON	1900	60		B & RT	NO	1
G 2	BOSTON	ALBANY ST. GARAGE	GARAGE	421 ALBANY ST.	1930	60			NO	3
G 3	CAMBRIDGE	ALEWIFE STATION	GARAGE	ALEWIFE BROOK PK	1970			LR	YES	3
G 4	BOSTON	ARLINGTON AVE.	GARAGE	21 ARLINGTON AVE	1970	100	15		YES	3
G 5	BOSTON	BARTLETT STATION	GARAGE	2565 WASHINGTON	1920	4			NO	1
G 6	BOSTON	BOSTON COLLEGE	GARAGE	COMMONWEALTH AVE	1960		1	LR	NO	2
G 7	BOSTON	BOWDOIN STATION	GARAGE		1960			RT	NO	2
G 8	BOSTON	CABOT CENTER	GARAGE	275 DORCESTER	1966	500	20	B	YES	3
G 9	BRAINTREE	CADIGAN YARD	GARAGE	OUT OF STUDY						
G10	BOSTON	CODMAN YARD	GARAGE	GALLIVAN BLVD	1930	4		RT	NO	1
G11	BOSTON	CHARLESTOWN GARAGE	GARAGE	21 ARLINGTON AVE	1970	500	30		YES	3
G12	MEDFORD	FELLSWAY GARAGE	GARAGE	447 SALEM ST.	1900	4		B	NO	3
G13	BOSTON	FOREST HILLS	GARAGE	WASHINGTON ST.	1920			RT	NO	1
G14	CAMBRIDGE	LECHMERE STATION	GARAGE	E.CAMBRIDGE ST.	1900			LR	NO	2
G15	LYNN	LYNN GARAGE	GARAGE	985 WESTERN AVE.	1900	50	8	B	NO	2
G16	BOSTON	MATTAPAN YARD	GARAGE	516 RIVER ST.	1900			LR	NO	3
G17	CAMBRIDGE	NORTH CAMBRIDGE	GARAGE	2375 MASS.AVE.	1960	32	6	TT	YES	3
G18	BOSTON	ORIENT HEIGHTS	GARAGE	21 BARNES AVE.	1950	24	110	RT	NO	2
G19	QUINCY	QUINCY GARAGE	GARAGE	954 HANCOCK ST.	1940	6		B	NO	3
G20	BROOKLINE	RESERVOIR CARHOUSE	GARAGE	600 CHESTNUT H.	1970	44	16	LR	YES	1
G21	NEWTON	RIVERSIDE CARHOUSE	GARAGE	339 GROVE ST.	1970	100	40	LR	YES	3
G22	WATERTOWN	WATERTOWN CARHOUSE	GARAGE	24 GALEN ST.	1900	6		TT	NO	3
G23	MEDFORD	WELLINGTON CARHOUSE	GARAGE	37 REVERE BEACH	1970	160	36	RT	YES	3
G24	EVERETT	EVERETT SHOPS	GARAGE	80 BROADWAY	1900	150	50		YES	3
G25	MALDEN	OAK GROVE	TERMINAL							3
G26	REVERE	WONDERLAND	TERMINAL							3
G27	CAMBRIDGE	BOSTON ENGINE TERMINAL	TERMINAL					CR		3

KEY

VEHICLE TYPE
- B = BUS
- RT = RAPID RAIL TRANSIT
- LR = LIGHT RAIL (STREET CAR)
- TT = TRACKLESS TROLLEY
- CR = COMMUTER RAIL

TABLE 3.5k

TRANSPORTATION FACILITIES AND SYSTEMS: HIGHWAY FACILITIES

REPLACEMENT VALUES ($-THOUSANDS)

BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	ZONES \ CELLS	1-9	1-3	1-6,8-9	4-6	7	8-9
ELEVATED HIGHWAYS	13	1	-					
		2	-					
		3	92,000					
HIGHWAY INTERCHANGES	13	1		2,700		2,160	-	3,780
		2		360		1,080	-	-
		3		3,780		12,870	5,940	2,520
TUNNELS	19	1	-					
		2	-					
		3	79,750					
BRIDGES	13	1			-		-	
		2			-		-	
		3			64,800		151,800	

TABLE 3.51
TRANSPORTATION FACILITIES AND SYSTEMS: AIRPORT FACILITES
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9
TERMINAL BUILDINGS	6	1	-
		2	-
		3	343,330
TOWERS	18	1	-
		2	-
		3	22,700
HANGERS AND SUPPORT FACILITES	10	1	-
		2	-
		3	198,700
GARAGES	7	1	-
		2	-
		3	8,798

TABLE 3.5m
TRANSPORTATION FACILITIES AND SYSTEMS: WATER PORTS
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	ZONES \ CELLS	5	7,9
DOCKS	23	1	-	-
		2	-	-
		3	68,250	109,900
CRANES	24	1	-	-
		2	-	-
		3	38,325	92,400

TABLE 3.5n
TRANSPORTATION FACILITIES AND SYSTEMS: PUBLIC TRANSIT FACILITIES
REPLACEMENT VALUES ($-THOUSAND)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9	1-5	6-9
RAPID TRANSIT RAIL STATIONS LOW-RISE MASONRY	3	1	4,180		
		2	2,780		
		3	20,880		
RAPID TRANSIT RAIL STATIONS LOW-RISE REIN. CONC.	6	1	4,180		
		2	2,780		
		3	20,880		
RAPID TRANSIT RAIL STATIONS LOW-RISE STEEL	10	1	2,080		
		2	1,400		
		3	10,440		
GARAGES AND TERMINALS LOW-RISE MASONRY	3	1		-	2,268
		2		1,836	864
		3		4,125	6,696
GARAGES AND TERMINALS LOW-RISE REIN. CONC.	6	1		-	2,268
		2		1,836	864
		3		4,125	6,696
GARAGES AND TERMINALS LOW-RISE STEEL	10	1		-	1,134
		2		918	432
		3		2,064	3,348
BRIDGES	13	1	-		
		2	-		
		3	12,800		

3.6 Gas and Petroleum Fuel Utilities

3.6.1 Overview. This category includes information on the natural gas system and petroleum fuels for the greater Boston area.

Natural Gas: Boston Gas provides gas service to almost all of the Metropolitan Boston area. The exceptions are Cambridge, Somerville, Dedham, and Wakefield. Cambridge and Somerville are serviced by Commonwealth Gas, and Wakefield is serviced by the Wakefield Gas and Electric Light Department. Dedham is serviced by both Commonwealth Gas and Boston Gas.

Boston Gas (New England's largest gas distributor) receives the majority of its gas from two natural gas pipelines, Algonquin Gas Transmission Company and Tennessee Gas Pipeline Company, which deliver gas from the gulf coast. The rest of the supply is liquefied natural gas (LNG), substitute natural gas (SNG), and propane. These supplementary sources are used when the demand for gas is most high.

LNG is natural gas "frozen" at -260°F. This process reduces the volume to 1/600 of its normal gaseous state and allows for the storage of a huge quantity of natural gas in a relatively small space. Boston gas has LNG tanks in Dorchester, Lynn, and Salem. There is also a large LNG plant in South Boston.

SNG plants were created to supplement fuel sources in response to the energy crisis a decade ago. SNG in the greater Boston area is provided by a plant in Everett during peak consumption periods.

Table 3.6a is a listing of natural gas plants, terminals, and storage facilities. Tables 3.6b, 3.6c, and 3.6d detail metering stations, regulating stations, and maintenance/garaging facilities, respectively.

Petroleum Fuels: As demonstrated in the table below, a large percentage of Massachusetts residential and total sector fuel usage is oil. As a result, oil is an important resource to the greater Boston area.

Fuel/Power Usage in Massachusetts in Trillion Btu*

Sector	Gas	Oil	Coal	Electricity
Residential	100.1	109.9	1.6	44.8
Commercial	42.4	49.0	1.6	53.9
Industrial	33.9	69.9	4.4	33.3
Transportation	1.4	379.2	0.0	0.6
Electrical Utilities	46.9	153.4	102.6	

**Source:* 1985 National Energy Commission Report

Massachusetts receives most of its petroleum fuel by ship. Major suppliers of petroleum fuels are located outside the study area north of Salem and south of Quincy. Fuel is trucked throughout the greater Boston area because there are no petroleum fuel distribution pipelines in the area.

Two large petroleum fuel storage facilities (32,249,700 and 29,899,170 gallons, respectively) are located in Chelsea, and another facility with a capacity of 43,890,000 gallons is in Waltham. See Table 3.6e for a complete listing of petroleum fuel storage sites.

3.6.2 Engineering Classification and Replacement Values. Maintenance and garaging facilities were not sampled, so an engineering structure classification of low-rise masonry was assumed for the four facilities.

Transmission lines were divided into two categories, main and distribution lines. Main lines were defined as high-pressure lines with

pressures of 25 to 60 psi. Distribution lines were defined as intermediate-pressure lines with pressures of 10 to 25 psi. In accordance with the methodology discussed in Chapter 4, the damage of transmission lines is reported in terms of breaks per mile. Therefore, the replacement value table reports pipelines in terms of total miles rather than cost.

Replacement values for all gas and petroleum fuel facilities are indicated by engineering structure classification, cells, and seismic hazard zones in Table 3.6f.

TABLE 3.6a

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - TERMINALS, PLANTS, AND STORAGE FACILITIES

CODE	CITY	OPERATOR OF FACILITY	TYPE OF FACILITY	QUANTITY STORED	YEAR BUILT	SEISMIC HAZARD
T1	BOSTON	BOSTON GAS CO.	LNG TANKS, DISPATCHING CTR.	290,000 BARRELS	1968	3
T2	BOSTON	BOSTON GAS CO.	LNG TANKS, DISPATCHING CTR.	331,000 BARRELS	1971	3
T3	LYNN	BOSTON GAS CO.	LNG TANKS, MASSACHUSETTS LNG	290,000 BARRELS	1972	3
T4	SALEM	BOSTON GAS CO.	LNG TANKS, MASSACHUSETTS LNG	290,000 BARRELS	1972	3
T5	EVERETT	DISTRIGAS	LNG TANKS			3
T6	EVERETT	BOSTON GAS CO.	PROPANE,LNG,SNG TANKS	697,000 GALLONS	1947	3
T7	REVERE	BOSTON GAS CO.	PROPANE TANKS	153,000 GALLONS	1961	3

TABLE 3.6b

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - METERING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	SEISMIC HAZARD
MS1	ARLINGTON	TENNESSEE GAS CO.	TOWER RD.	METERING, TAKE STATION	1
MS2	BEDFORD	TENNESSEE GAS CO.	HARTWELL ST.	METERING, TAKE STATION (LEXINGTON)	2
MS3	EVERETT	ALGONQUIN GAS CO.	ROVER ST.	METERING STATION	3
MS4	LYNN	ALGONQUIN GAS CO.	WINNEPURKIT RD.	METERING, TAKE STATION	1
MS5	MALDEN	TENNESSEE GAS CO.	NORTHEASTERN EXPRESSWAY	METERING, TAKE STATION (REVERE)	1
MS6	MILTON	ALGONQUIN GAS CO.	near BLUE HILLS RESERVATION	METERING STATION	1
MS7	WALTHAM	ALGONQUIN GAS CO.	TRAPELO RD.	METERING STATION	1

TABLE 3.6c

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R 1	ARLINGTON	BOSTON GAS CO.	APPLETON ST.	REGULATOR			1
R 2	ARLINGTON	BOSTON GAS CO.	ARNOLD RD.	REGULATOR			1
R 3	ARLINGTON	BOSTON GAS CO.	COLLEGE AVE. @ MYSTIC	REGULATOR			1
R 4	ARLINGTON	BOSTON GAS CO.	LAKE @ FREEMAN	REGULATOR			3
R 5	ARLINGTON	BOSTON GAS CO.	PARK @ CEDAR	REGULATOR			1
R 6	ARLINGTON	BOSTON GAS CO.	RUSSELL @ MYSTIC	REGULATOR			3
R 7	ARLINGTON	BOSTON GAS CO.	SUMMER @ FORREST	REGULATOR			1
R 8	ARLINGTON	BOSTON GAS CO.	SUMMER @ WASHINGTON	REGULATOR			1
R 9	BELMONT	BOSTON GAS CO.	MILL @ TRAPELO RD.	REGULATOR			1
R 10	BELMONT	BOSTON GAS CO.	PLEASANT @ LAKE	REGULATOR			3
R 11	BELMONT	BOSTON GAS CO.	SCHOOL @ COTTAGE	REGULATOR			2
R 12	BELMONT	BOSTON GAS CO.	SCHOOL @ ELM	REGULATOR			2
R 13	BOSTON	BOSTON GAS CO.	ADAMS ST. @ MINOT ST.	REGULATOR			1
R 14	BOSTON	BOSTON GAS CO.	ARLINGTON AVE @ DORRANCE ST.	REGULATOR			3
R 15	BOSTON	BOSTON GAS CO.	ARLINGTON AVE. @ BEECHAM ST.	REGULATOR			3
R 16	BOSTON	BOSTON GAS CO.	AVON ST @ POND ST.	REGULATOR			1
R 17	BOSTON	BOSTON GAS CO.	BEECH ST. @ WASHINGTON AVE.	REGULATOR			2
R 18	BOSTON	BOSTON GAS CO.	BERKELEY ST. @ CORTES ST.	REGULATOR			3
R 19	BOSTON	BOSTON GAS CO.	BLUE HILL AVE. @ MORTON ST.	REGULATOR			1
R 20	BOSTON	BOSTON GAS CO.	BLUE HILL AVE. @ TALBOT AVE.	REGULATOR			1
R 21	BOSTON	BOSTON GAS CO.	BOWDOIN ST. @ QUINCY ST.	REGULATOR			1
R 22	BOSTON	BOSTON GAS CO.	BRIGHTON AVE. @ LINDEN ST.	REGULATOR			3
R 23	BOSTON	BOSTON GAS CO.	BROOKS ST. @ NONANTUM RD.	REGULATOR			2
R 24	BOSTON	BOSTON GAS CO.	BUTTONWOOD ST. @ MT.VERNON ST.	REGULATOR			3
R 25	BOSTON	BOSTON GAS CO.	CALL ST. @ McBRIDE ST.	REGULATOR			3
R 26	BOSTON	BOSTON GAS CO.	CENTRE ST. @ DORCESTER AVE.	REGULATOR			1
R 27	BOSTON	BOSTON GAS CO.	CENTRE ST. @ GROVE ST.	REGULATOR			1
R 28	BOSTON	BOSTON GAS CO.	CENTRE ST. @ TEMPLE ST.	REGULATOR			1
R 29	BOSTON	BOSTON GAS CO.	CENTRE ST. @ WILLOW ST.	REGULATOR			1
R 30	BOSTON	BOSTON GAS CO.	CITY SQ.	REGULATOR			3

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R 31	BOSTON	BOSTON GAS CO.	CLEVELAND CIRCLE	REGULATOR			1
R 32	BOSTON	BOSTON GAS CO.	E ST. @ FARGO ST.	REGULATOR			3
R 33	BOSTON	BOSTON GAS CO.	EAGLE SQ.	REGULATOR			3
R 34	BOSTON	BOSTON GAS CO.	ESSEX ST. @ RUTHERFORD AVE.	REGULATOR			3
R 35	BOSTON	BOSTON GAS CO.	GENEVA ST. @ MAVERICK	REGULATOR			3
R 36	BOSTON	BOSTON GAS CO.	HEATH ST. @ SCHILLER ST.	REGULATOR			1
R 37	BOSTON	BOSTON GAS CO.	HYDE PARK AVE. @ STELLA RD.	REGULATOR			1
R 38	BOSTON	BOSTON GAS CO.	INDIA SQ. @ ATLANTIC AVE.	REGULATOR			3
R 39	BOSTON	BOSTON GAS CO.	KNEELAND ST. @ SOUTH ST.	REGULATOR			3
R 40	BOSTON	BOSTON GAS CO.	L ST. @ E.4TH	REGULATOR			3
R 41	BOSTON	BOSTON GAS CO.	MARBURY TERRACE @ AMORY ST.	REGULATOR			3
R 42	BOSTON	BOSTON GAS CO.	MATTAPAN SQ.	REGULATOR			3
R 43	BOSTON	BOSTON GAS CO.	N.BEACON ST. @ CAMBRIDGE ST.	REGULATOR			3
R 44	BOSTON	BOSTON GAS CO.	NORFOLK ST. @ WOODROW AVE.	REGULATOR			1
R 45	BOSTON	BOSTON GAS CO.	NORTHHAMPTON ST. @ ALBANY ST.	REGULATOR			3
R 46	BOSTON	BOSTON GAS CO.	PORTER ST. @ CHELSEA ST.	REGULATOR			3
R 47	BOSTON	BOSTON GAS CO.	RESERVOIR RD. @ BEACON ST.	REGULATOR			1
R 48	BOSTON	BOSTON GAS CO.	ROCKWOOD ST.	REGULATOR			1
R 49	BOSTON	BOSTON GAS CO.	SARATOGA ST. @ BOARDMAN ST.	REGULATOR			3
R 50	BOSTON	BOSTON GAS CO.	SAVIN HILL AVE. @ DORCESTER AVE.	REGULATOR			3
R 51	BOSTON	BOSTON GAS CO.	SEAVERNS AVE. @ BROWN TERRACE	REGULATOR			1
R 52	BOSTON	BOSTON GAS CO.	SOUTHHAMPTON ST. @ BRADSTON ST.	REGULATOR			3
R 53	BOSTON	BOSTON GAS CO.	STANIFORD ST. @ CAMBRIDGE ST.	REGULATOR			2
R 54	BOSTON	BOSTON GAS CO.	THACHER ST. @ PRINCE ST.	REGULATOR			1
R 55	BOSTON	BOSTON GAS CO.	W.2ND @ W.3RD	REGULATOR			3
R 56	BOSTON	BOSTON GAS CO.	WALNUT AVE. @ CRAWFORD ST.	REGULATOR			1
R 57	BOSTON	BOSTON GAS CO.	WARREN ST. @ TOWNSEND ST.	REGULATOR			1
R 58	BOSTON	BOSTON GAS CO.	WATER ST. @ PORT NORFOLK ST.	REGULATOR			3
R 59	BOSTON	BOSTON GAS CO.	WAVERLY ST. @ MACKIN ST.	REGULATOR			3
R 60	BOSTON	BOSTON GAS CO.	WELD ST. @ CENTRE ST.	REGULATOR			1

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R 61	BOSTON	COMMONWEALTH GAS	B ST. @ HYDE PARK AVE.	REGULATOR	MASONRY	1959	1
R 62	BOSTON	COMMONWEALTH GAS	FAIRMOUNT AVE. @ WALNUT ST.	REGULATOR			1
R 63	BOSTON	COMMONWEALTH GAS	GEORGE ST. near RIVER ST.	REGULATOR	REIN. CONC.	1981	1
R 64	BOSTON	COMMONWEALTH GAS	HUNTINGTON AVE. @ RIVER ST.	REGULATOR	REIN. CONC.	1973	1
R 65	BOSTON	COMMONWEALTH GAS	HYDE PARK AVE. @ PINGREE ST.	REGULATOR	REIN. CONC.	1970	1
R 66	BOSTON	COMMONWEALTH GAS	RESERVATION RD. @ ROXANNA	REGULATOR	REIN. CONC.	1966	1
R 67	BOSTON	COMMONWEALTH GAS	RIVER ST. @ WEST ST.	REGULATOR	REIN. CONC.	1973	1
R 68	BOSTON	COMMONWEALTH GAS	THATCHER ST. @ HYDE PARK AVE.	REGULATOR	REIN. CONC.	1959	1
R 69	BOSTON	COMMONWEALTH GAS	TRUMAN HWY. @ FAIRMOUNT AVE.	REGULATOR	REIN. CONC.	1981	1
R 70	BROOKLINE	BOSTON GAS CO.	ASPINWALL AVE. @ HARVARD AVE.	REGULATOR			3
R 71	BROOKLINE	BOSTON GAS CO.	BOYLSTON ST. @ CYPRESS ST.	REGULATOR			1
R 72	BROOKLINE	BOSTON GAS CO.	BOYLSTON ST. @ FISHER AVE.	REGULATOR			1
R 73	BROOKLINE	BOSTON GAS CO.	HARVARD ST. @ BEACON ST.	REGULATOR			2
R 74	BROOKLINE	BOSTON GAS CO.	NEWTON ST. @ LAGRANGE ST.	REGULATOR			1
R 75	CAMBRIDGE	COMMONWEALTH GAS	ALLSTON ST. @ RIVER ST.	REGULATOR	REIN. CONC.	1962	3
R 76	CAMBRIDGE	COMMONWEALTH GAS	BEECH ST.	REGULATOR	REIN. CONC.	1958	3
R 77	CAMBRIDGE	COMMONWEALTH GAS	CAMERON AVE.	REGULATOR	MASONRY	1942	3
R 78	CAMBRIDGE	COMMONWEALTH GAS	CONCORD AVE. near SUNNY RD.	REGULATOR	REIN. CONC.	1961	3
R 79	CAMBRIDGE	COMMONWEALTH GAS	CONCORD AVE. near WHEELER ST.	REGULATOR	REIN. CONC.	1959	3
R 80	CAMBRIDGE	COMMONWEALTH GAS	FAYERWEATHER ST. @ BRATTLE ST.	REGULATOR	REIN. CONC.	1968	3
R 81	CAMBRIDGE	COMMONWEALTH GAS	HURON AVE. near FRESH POND PKWY.	REGULATOR	REIN. CONC.	1960	3
R 82	CAMBRIDGE	COMMONWEALTH GAS	PUTNAM AVE. @ PEARL ST.	REGULATOR	REIN. CONC.	1956	3
R 83	CAMBRIDGE	COMMONWEALTH GAS	SHERMAN ST. @ WALDEN ST.	REGULATOR			3
R 84	CAMBRIDGE	COMMONWEALTH GAS	VASSAR ST. @ AUDREY	REGULATOR	REIN. CONC.	1962	3
R 85	CAMBRIDGE	COMMONWEALTH GAS	WESTERN AVE. @ BLACKSTONE ST.	REGULATOR	REIN. CONC.	1968	3
R 86	CAMBRIDGE	COMMONWEALTH GAS	BROOKFORD ST.	TAKE STATION	MASONRY	1966	3
R 87	CAMBRIDGE	COMMONWEALTH GAS	THIRD ST. near POTTER ST.	TAKE STATION	MASONRY	1954	3
R 88	CHELSEA	BOSTON GAS CO.	ARLINGTON ST. @ 5TH ST.	REGULATOR			3
R 89	CHELSEA	BOSTON GAS CO.	WEBSTER AVE. @ SUMMIT AVE.	REGULATOR			3
R 90	CHELSEA	BOSTON GAS CO.	WILLIAMS ST. @ SPRUCE ST.	REGULATOR			2

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R 91	DEDHAM	COMMONWEALTH GAS	COURT ST. @ VILLAGE AVE.	REGULATOR	REIN. CONC.	1949	2
R 92	DEDHAM	COMMONWEALTH GAS	DEDHAM BLVD. @ HARDING TERRACE	REGULATOR	STEEL	1966	1
R 93	DEDHAM	COMMONWEALTH GAS	EAST ST. @ SPRAUGUE ST.	REGULATOR	REIN. CONC.	1947	2
R 94	DEDHAM	COMMONWEALTH GAS	EAST ST. @ WHITING AVE.	REGULATOR	REIN. CONC.	1959	1
R 95	DEDHAM	COMMONWEALTH GAS	MILTON ST. @ QUINCY AVE.	REGULATOR	MASONRY	1956	1
R 96	DEDHAM	COMMONWEALTH GAS	NEEDHAM ST. @ BULLARD RD.	REGULATOR	REIN. CONC.	1973	3
R 97	DEDHAM	COMMONWEALTH GAS	WASHINGTON ST. @ DEDHAM PLAZA	REGULATOR	STEEL		3
R 98	EVERETT	BOSTON GAS CO.	CLINTON @ COTTAGE	REGULATOR			2
R 99	EVERETT	BOSTON GAS CO.	ELM @ FERRY	REGULATOR			2
R100	EVERETT	BOSTON GAS CO.	LINDEN @ HANCOCK	REGULATOR			2
R101	EVERETT	BOSTON GAS CO.	SPAULDING ST.	REGULATOR			2
R102	EVERETT	BOSTON GAS CO.	WINTER ST. @ REVERE BEACH PKWY.	REGULATOR			3
R103	LEXINGTON	BOSTON GAS CO.	ELDRED @ BEDFORD	REGULATOR			3
R104	LEXINGTON	BOSTON GAS CO.	MASSACHUSETTS AVE. (IP)	REGULATOR			2
R105	LEXINGTON	BOSTON GAS CO.	MASSACHUSETTS AVE. (MP)	REGULATOR			2
R106	LEXINGTON	BOSTON GAS CO.	SIMMONDS RD.	REGULATOR			1
R107	LYNN	BOSTON GAS CO.	AUSTIN SQ.	REGULATOR			2
R108	LYNN	BOSTON GAS CO.	BOSTON @ KIRKLAND	REGULATOR			2
R109	LYNN	BOSTON GAS CO.	BOSTON @ NORTHSIDE	REGULATOR			2
R110	LYNN	BOSTON GAS CO.	BUBBIER ST. @ LYNNWAY	REGULATOR			3
R111	LYNN	BOSTON GAS CO.	GENERAL ELECTRIC near LYNNWAY	REGULATOR (3)			3
R112	LYNN	BOSTON GAS CO.	LUFKEN ST.	REGULATOR			1
R113	LYNN	BOSTON GAS CO.	LYNNFIELD ST.	REGULATOR			1
R114	LYNN	BOSTON GAS CO.	MAGNOLIA @ BROADWAY	REGULATOR			3
R115	LYNN	BOSTON GAS CO.	PRESIDENT ST.	REGULATOR			1
R116	LYNN	BOSTON GAS CO.	RANGE @ LONGWOOD	REGULATOR			1
R117	LYNN	BOSTON GAS CO.	SAUNDERS near GLENWOOD	REGULATOR			1
R118	LYNN	BOSTON GAS CO.	TRAFFIC RD. @ LYNNWAY	REGULATOR			3
R119	LYNN	BOSTON GAS CO.	WESTERN AVE. @ MAPLE ST.	REGULATOR			1
R120	LYNN	BOSTON GAS CO.	WINNEPURKIT	REGULATOR			1

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R121	MALDEN	BOSTON GAS CO.	B&M R.R. @ BRYANT ST.	REGULATOR			3
R122	MALDEN	BOSTON GAS CO.	BELMONT @ FERRY	REGULATOR			3
R123	MALDEN	BOSTON GAS CO.	CLIFTON @ WASHINGTON	REGULATOR			3
R124	MALDEN	BOSTON GAS CO.	GARDEN @ LEBANON	REGULATOR			1
R125	MALDEN	BOSTON GAS CO.	HIGHLAND AVE. @ CLIFTON	REGULATOR			1
R126	MALDEN	BOSTON GAS CO.	LINDEN GOVERNOR HOUSE	REGULATOR			3
R127	MALDEN	BOSTON GAS CO.	MAPLEWOOD ST.	REGULATOR			3
R128	MALDEN	BOSTON GAS CO.	PEARL ST. @ ADAMS	REGULATOR			3
R129	MALDEN	BOSTON GAS CO.	SHEAFE @ EASTERN	REGULATOR (2)			3
R130	MARBLEHEAD	BOSTON GAS CO.	BALDWIN ST.	REGULATOR			1
R131	MARBLEHEAD	BOSTON GAS CO.	BEACON ST.	REGULATOR			1
R132	MARBLEHEAD	BOSTON GAS CO.	BEACON ST. @ WEST SHORE DR.	REGULATOR			2
R133	MARBLEHEAD	BOSTON GAS CO.	EVANS @ ELM	REGULATOR			1
R134	MARBLEHEAD	BOSTON GAS CO.	EVANS near WEST SHORE DR.	REGULATOR			2
R135	MARBLEHEAD	BOSTON GAS CO.	HUMPHREY ST.	REGULATOR			2
R136	MARBLEHEAD	BOSTON GAS CO.	TEDESCO ST.	REGULATOR			2
R137	MARBLEHEAD	BOSTON GAS CO.	WEST SHORE DR. @ JERSEY ST.	REGULATOR			2
R138	MEDFORD	BOSTON GAS CO.	BENMOR AVE.	REGULATOR			1
R139	MEDFORD	BOSTON GAS CO.	BOSTON @ HARVARD	REGULATOR			3
R140	MEDFORD	BOSTON GAS CO.	BOSTON @ HIGH	REGULATOR			3
R141	MEDFORD	BOSTON GAS CO.	EMERY ST.	REGULATOR			1
R142	MEDFORD	BOSTON GAS CO.	HARVARD @ MAIN	REGULATOR			3
R143	MEDFORD	BOSTON GAS CO.	MIDDLESEX @ FOURTH ST.	REGULATOR			3
R144	MEDFORD	BOSTON GAS CO.	SALEM @ RIVER	REGULATOR			3
R145	MEDFORD	BOSTON GAS CO.	SPRING @ RIVERSIDE	REGULATOR			3
R146	MEDFORD	BOSTON GAS CO.	WINTHROP SQ. @ GOVERNOR HOUSE	REGULATOR			3
R147	MEDFORD	BOSTON GAS CO.	WYMAN @ WOBURN ST.	REGULATOR			2
R148	MELROSE	BOSTON GAS CO.	FLORENCE @ WYOMING	REGULATOR			3
R149	MELROSE	BOSTON GAS CO.	GREEN @ SHORT	REGULATOR			2
R150	MELROSE	BOSTON GAS CO.	LEBANON @ EMERSON	REGULATOR			2

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R151	MELROSE	BOSTON GAS CO.	LEBANON @ FOREST	REGULATOR			1
R152	MELROSE	BOSTON GAS CO.	PLEASANT @ WYOMING	REGULATOR			3
R153	MELROSE	BOSTON GAS CO.	VINTON @ W.EMERSON	REGULATOR			2
R154	MELROSE	BOSTON GAS CO.	WARREN @ FRANKLIN	REGULATOR (2)			2
R155	MILTON	BOSTON GAS CO.	ADAMS ST. @ SQUANTUM ST.	REGULATOR			1
R156	MILTON	BOSTON GAS CO.	BRUSH HILL RD. @ ROBBINS ST.	REGULATOR			1
R157	MILTON	BOSTON GAS CO.	CENTRAL AVE. @ BROOK RD.	REGULATOR			3
R158	NAHANT	BOSTON GAS CO.	CASTLE RD. @ NAHANT RD.	REGULATOR			3
R159	NAHANT	BOSTON GAS CO.	LITTLE NAHANT RD.	REGULATOR			3
R160	NEWTON	BOSTON GAS CO.	BEACON ST. @ HAMMOND ST.	REGULATOR			2
R161	NEWTON	BOSTON GAS CO.	BEACON ST. @ WABAN ST.	REGULATOR			2
R162	NEWTON	BOSTON GAS CO.	BROOKSIDE AVE. @ WASHINGTON ST.	REGULATOR			2
R163	NEWTON	BOSTON GAS CO.	CALIFORNIA ST. @ BRIDGE ST.	REGULATOR			3
R164	NEWTON	BOSTON GAS CO.	CHESTNUT ST. @ AUSTIN ST.	REGULATOR			3
R165	NEWTON	BOSTON GAS CO.	COMMONWEALTH AVE. @ WASHINGTON ST	REGULATOR			2
R166	NEWTON	BOSTON GAS CO.	FLORENCE ST. @ BOYLSTON ST.	REGULATOR			1
R167	NEWTON	BOSTON GAS CO.	GRAFTON ST. @ HOMER ST.	REGULATOR			2
R168	NEWTON	BOSTON GAS CO.	LOWELL ST. @ HIGHLAND ST.	REGULATOR			2
R169	NEWTON	BOSTON GAS CO.	NAHANTON ST. @ DEDHAM ST.	REGULATOR			1
R170	NEWTON	BOSTON GAS CO.	OAK ST. @ NEEDHAM ST.	REGULATOR			3
R171	NEWTON	BOSTON GAS CO.	RICHARDSON ST. @ CENTRE AVE.	REGULATOR			2
R172	NEWTON	BOSTON GAS CO.	W.NEWTON SQ.	REGULATOR			2
R173	NEWTON	BOSTON GAS CO.	WALNUT ST. @ BEACON ST.	REGULATOR			2
R174	QUINCY	BOSTON GAS CO.	ADAMS ST. @ HANCOCK ST.	REGULATOR			3
R175	QUINCY	BOSTON GAS CO.	ADAMS ST. @ ROBERTSON ST.	REGULATOR			1
R176	QUINCY	BOSTON GAS CO.	BICKNELL ST. @ TAFFRAIL RD.	REGULATOR			3
R177	QUINCY	BOSTON GAS CO.	CENTRE ST. @ PENN ST.	REGULATOR			3
R178	QUINCY	BOSTON GAS CO.	QUINCY SHORE DR. @ ATLANTIC ST.	REGULATOR			3
R179	QUINCY	BOSTON GAS CO.	QUINCY SHORE DR. @ E.SQUANTUM ST.	REGULATOR			3
R180	QUINCY	BOSTON GAS CO.	SEA ST. @ DELANO AVE.	REGULATOR			3

TABLE 3.6c (cont.)
GAS AND PETROLEUM FUEL UTILITIES
NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R181	QUINCY	BOSTON GAS CO.	SEA ST. @ HIBBARD ST.	REGULATOR			3
R182	QUINCY	BOSTON GAS CO.	SEA ST. @ SOUTHERN ARTERY	REGULATOR			3
R183	QUINCY	BOSTON GAS CO.	W.SQUANTUM ST. @ HANCOCK ST.	REGULATOR			3
R184	QUINCY	BOSTON GAS CO.	WASHINGTON ST. @ SOUTHERN ARTERY	REGULATOR			3
R185	REVERE	BOSTON GAS CO.	AMERICAN LEGION HWY.	REGULATOR			3
R186	REVERE	BOSTON GAS CO.	CRESCENT AVE.	REGULATOR			3
R187	REVERE	BOSTON GAS CO.	HYDE ST.	REGULATOR			3
R188	REVERE	BOSTON GAS CO.	MALDEN @ TUCKERMAN	REGULATOR			2
R189	REVERE	BOSTON GAS CO.	OAK ISLAND	REGULATOR			3
R190	REVERE	BOSTON GAS CO.	OCEAN @ REVERE ST.	REGULATOR (2)			3
R191	REVERE	BOSTON GAS CO.	POINT OF PINES	REGULATOR			3
R192	REVERE	BOSTON GAS CO.	WINTHROP AVE. @ NORTH SHORE RD.	REGULATOR			3
R193	REVERE	BOSTON GAS CO.	WOODLAWN @ GOVERNOR HOUSE	REGULATOR			2
R194	SALEM	BOSTON GAS CO.	BOSTON @ ABORN	REGULATOR			1
R195	SALEM	BOSTON GAS CO.	BRIDGE near BY-PASS RD.	REGULATOR			3
R196	SALEM	BOSTON GAS CO.	CANAL @ LORING	REGULATOR			3
R197	SALEM	BOSTON GAS CO.	COLUMBUS @ BAY VIEW	REGULATOR			1
R198	SALEM	BOSTON GAS CO.	FEDERAL @ BECKFORD	REGULATOR			3
R199	SALEM	BOSTON GAS CO.	OCEAN @ BROADWAY	REGULATOR			3
R200	SALEM	BOSTON GAS CO.	WASHINGTON @ MILL	REGULATOR			3
R201	SAUGUS	BOSTON GAS CO.	CENTRAL @ ELM	REGULATOR			3
R202	SAUGUS	BOSTON GAS CO.	CENTRAL @ LINCOLN AVE.	REGULATOR			1
R203	SAUGUS	BOSTON GAS CO.	CENTRAL ST.	REGULATOR			1
R204	SAUGUS	BOSTON GAS CO.	DUDLEY @ LINCOLN AVE.	REGULATOR			1
R205	SAUGUS	BOSTON GAS CO.	ESSEX ST.	REGULATOR			3
R206	SAUGUS	BOSTON GAS CO.	MAIN @ NEWHALL	REGULATOR			3
R207	SAUGUS	BOSTON GAS CO.	MAIN ST.	REGULATOR			1
R208	SOMERVILLE	BOSTON GAS CO.	PEARL ST. @ PICKNEY ST.	REGULATOR			3
R209	SOMERVILLE	COMMONWEALTH GAS	BEACON ST. @ WASHINGTON	REGULATOR	REIN. CONC.	1959	3
R210	SOMERVILLE	COMMONWEALTH GAS	HARVARD ST. @ BENTON RD.	REGULATOR	REIN. CONC.	1959	2

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R211	SOMERVILLE	COMMONWEALTH GAS	NEWTON ST.@ CLARK ST.	REGULATOR	REIN. CONC.	1959	3
R212	SOMERVILLE	COMMONWEALTH GAS	NORTH ST. @ BROADWAY	REGULATOR	REIN. CONC.	1959	2
R213	SOMERVILLE	COMMONWEALTH GAS	PACKARD AVE. @ BROADWAY	REGULATOR	REIN. CONC.	1965	2
R214	SOMERVILLE	COMMONWEALTH GAS	SOMERVILLE AVE. @ PARK ST.	REGULATOR	REIN. CONC.	1972	3
R215	SOMERVILLE	COMMONWEALTH GAS	SOMERVILLE AVE. @ WILSON SQ.	REGULATOR	REIN. CONC.	1961	2
R216	STONEHAM	BOSTON GAS CO.	FRANKLIN @ PLEASANT	REGULATOR			1
R217	STONEHAM	BOSTON GAS CO.	GOVERNOR @ MAIN	REGULATOR			1
R218	STONEHAM	BOSTON GAS CO.	POMEWORTH ST.	REGULATOR			1
R219	STONEHAM	BOSTON GAS CO.	SUMMER @ POND	REGULATOR			1
R220	SWAMPSCOTT	BOSTON GAS CO.	BURRILL @ FARRAGUT	REGULATOR			1
R221	SWAMPSCOTT	BOSTON GAS CO.	PARADISE RD.	REGULATOR (2)			2
R222	WAKEFIELD	BOSTON GAS CO.	LOWELL ST.	REGULATOR			2
R223	WAKEFIELD	BOSTON GAS CO.	MAIN ST. @ NORTH AVE.	REGULATOR			1
R224	WAKEFIELD	BOSTON GAS CO.	OAK ST. @ GOVERNOR HOUSE	REGULATOR			1
R225	WAKEFIELD	BOSTON GAS CO.	WAKEFIELD WORKS GOVERNOR HOUSE	REGULATOR			1
R226	WALTHAM	BOSTON GAS CO.	GORE ST. @ MAIN ST.	REGULATOR			1
R227	WALTHAM	BOSTON GAS CO.	LEXINGTON ST. @ TRAPELO RD.	REGULATOR			1
R228	WALTHAM	BOSTON GAS CO.	PINE ST. @ GARDNER ST.	REGULATOR			3
R229	WATERTOWN	BOSTON GAS CO.	DUFF ST. @ BELMONT ST.	REGULATOR			1
R230	WATERTOWN	BOSTON GAS CO.	GALEN ST. @ CAPITOL ST.	REGULATOR			3
R231	WATERTOWN	BOSTON GAS CO.	LOUISE ST. @ ARSENAL ST.	REGULATOR			3
R232	WATERTOWN	BOSTON GAS CO.	MYRTLE ST. @ MAIN ST.	REGULATOR			3
R233	WATERTOWN	BOSTON GAS CO.	TEMPLETON PKWY. @ MT.AUBURN ST.	REGULATOR			2
R234	WINCHESTER	BOSTON GAS CO.	BACON @ MAIN	REGULATOR			1
R235	WINCHESTER	BOSTON GAS CO.	CROSS ST.	REGULATOR			3
R236	WINCHESTER	BOSTON GAS CO.	EVERETT @ SHEFFIELD	REGULATOR			1
R237	WINCHESTER	BOSTON GAS CO.	WILDWOOD ST.	REGULATOR			1
R238	WINTHROP	BOSTON GAS CO.	HARVARD @ REVERE	REGULATOR			2
R239	WINTHROP	BOSTON GAS CO.	PAULINE @ PLEASANT	REGULATOR			2
R240	WINTHROP	BOSTON GAS CO.	SHIRLEY @ BAY VIEW	REGULATOR			3

TABLE 3.6c (cont.)

GAS AND PETROLEUM FUEL UTILITIES

NATURAL GAS - REGULATING STATIONS

CODE	CITY	OPERATOR OF FACILITY	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
R241	WINTHROP	BOSTON GAS CO.	SHIRLEY @ UNDERHILL	REGULATOR			3
R242	WOBURN	BOSTON GAS CO.	BOW @ SALEM	REGULATOR			2
R243	WOBURN	BOSTON GAS CO.	CAMPBELL @ WADE	REGULATOR			2
R244	WOBURN	BOSTON GAS CO.	CLINTON @ MAIN	REGULATOR			2
R245	WOBURN	BOSTON GAS CO.	DRACON CT.	REGULATOR			1
R246	WOBURN	BOSTON GAS CO.	FOWLE ST.	REGULATOR			2
R247	WOBURN	BOSTON GAS CO.	HOUGHTON @ HARRISON	REGULATOR			1
R248	WOBURN	BOSTON GAS CO.	JEFFERSON @ EASTERN	REGULATOR			2
R249	WOBURN	BOSTON GAS CO.	MERRIMAC	REGULATOR			2
R250	WOBURN	BOSTON GAS CO.	MISHAWAM RD.	REGULATOR			1
R251	WOBURN	BOSTON GAS CO.	PEARL ST.	REGULATOR			1
R252	WOBURN	BOSTON GAS CO.	PINE ST.	REGULATOR			2
R253	WOBURN	BOSTON GAS CO.	WASHINGTON @ MONTVALE	REGULATOR			2
R254	WOBURN	BOSTON GAS CO.	WYMAN @ HART	REGULATOR (2)			2

TABLE 3.6d

GAS AND PETROLEUM FUEL FACILITIES

NATURAL GAS - MAINTENANCE AND GARAGING FACILITIES

CODE	CITY	LOCATION	TYPE OF FACILITY	VEHICLE CAPACITY	YEAR BUILT	SEISMIC HAZARD
M1	BOSTON	201 RIVERMORE ST.	MAINTENANCE	35	1975	3
M2	MALDEN	100 COMMERCIAL ST.	MAINTENANCE	30	1975	3
M3	LYNN	436 LYNNWAY	MAINTENANCE	8	1930	3
M4	WALTHAM	ELM ST.	MAINTENANCE	6	1985	3

TABLE 3.6e

GAS AND PETROLEUM FUEL UTILITIES

PETROLEUM FUEL-STORAGE FACILITIES

CODE	CITY	FACILITY NAME	LOCATION	GASOLINE (GALLONS)	NO. 2 FUEL (GALLONS)	OTHER FUELS (GALLONS)	TOTAL (GALLONS)	SEISMIC HAZARD
P 1	ARLINGTON	DUDLEY FUEL	43 DUDLEY	1,000	80,000	13,000	94,000	1
P 2	ARLINGTON	PAUL REVERE	1531 MASS AVE.	1,000	80,000		81,000	1
P 3	BOSTON	HUGHES OIL CO.	160 SPRING ST.		900,000		900,000	1
P 4	BOSTON	JAMES DEVANEY	19 SPRINGVALE		60,000		60,000	1
P 5	BOSTON	MELLO FUEL CO.	37 BROOKLY RD.		125,000	20,000	145,000	3
P 6	BOSTON	TEXACO OIL CO.	900E.1st. ST.				12,000,000	3
P 7	CHELSEA	GULF OIL CO.		13,714,806	32,249,700	5,460,000	51,424,506	3
P 8	CHELSEA	N.E.PETROLEUM	295 EASTERN AVE	6,913,200.	29,899,170	17,619,000	54,431,370	3
P 9	CHELSEA	TEXACO OIL CORP	99 MARGINAL ST.	9,592,800		1,158,200	10,751,000	3
P10	CHELSEA	ULTRAMAR PETROL			12,810,000	15,120,000	27,930,000	3
P11	DEDHAM	FISHER-CHURCHIL	580 PROVIDENCE	10,000	150,000		160,000	1
P12	EVERETT	EXXON CO.,USA	151 BOW ST.	18,005,506	38,666,544	39,075,212	95,746,812	2
P13	LEXINGTON	ARLEX OIL CO.	275 MASS AVE.	9,500	220,000	2,000	231,500	1
P14	LYNN	MORAN FUEL		3,000	30,000		33,000	2
P15	LYNN	PURITY OIL	170 ALLEY ST.		60,000		60,000	2
P16	MEDFORD	J.J.DONOVAN	35 SWAN		80,000	7,000	87,000	3
P17	MELROSE	BENSON GOSS OIL	20 TREMONT ST.	4,000	110,000		114,000	2
P18	NEWTON	R.T.RHODES & CO	1211 WASHINGTON					3
P19	QUINCY	QUINOIL INDUS.	10 MCGRATH HWY		15,540,000	14,700,000	30,240,000	3
P20	REVERE	GLOBAL PETROL.	140 LEE BURBANK	10,080,000	10,080,000	1,680,000	21,840,000	3
P21	SALEM	N.E.PETROLEUM			10,445,400	8,988,000	19,433,400	3
P22	WAKEFIELD	CURLEY	68 NORTH AVE.					3
P23	WALTHAM	EXXON	313 WAVERLY OAK	3,674,359	43,890,000		47,564,359	1
P24	WALTHAM	SHELL OIL CO.	313 WAVERLY OAK	5,544,000	6,384,000		11,928,000	1
P25	WINCHESTER	ULTRAMAR PETROL	36 CHURCH		120,000		120,000	3
P26	WOBURN	GINN OIL CO.	57 WINN ST.	32,500	60,000	2,500	95,000	2

TABLE 3.6f
GAS AND PETROLEUM FUEL UTILITIES
REPLACEMENT VALUES ($-THOUSAND OR TOTAL MILES)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9	1	2	3	4	5	6	7	8	9	1-4	5-9
NATURAL GAS MAIN TRANSMISSION LINES	20	1	15.4mi											
		2	3.2mi											
		3	9.1mi											
NATURAL GAS DISTRIBUTION LINES	20	1		12.3mi	11.3mi	16.0mi	10.6mi	4.2mi	7.2mi	2.2mi	14.7mi	18.7mi		
		2		9.3mi	3.8mi	8.1mi	5.1mi	9.2mi	11.4mi	1.0mi	5.3mi	0.2mi		
		3		9.9mi	0.5mi	7.2mi	13.9mi	17.7mi	12.5mi	19.8mi	1.9mi	17.3mi		
NATURAL GAS TERMINALS, PLANTS, AND STORAGE FACILITIES	15	1	-											
		2	-											
		3	87,600											
NATURAL GAS METERING STATIONS	26	1	500											
		2	100											
		3	100											
NATURAL GAS REGULATING STATIONS	26	1		357	334	189	324	130	97	190	258	721		
		2		204	182	270	162	195	177	190	52	-		
		3		306	122	54	389	757	145	1,018	34	541		
NATURAL GAS MAINTENANCE AND GARAGING FACILITIES	3	1	-											
		2	-											
		3	1,305											
PETROLEUM FUEL STORAGE FACILITIES	15	1											8,226	482
		2											275	14,511
		3											2,984	32,204

3.7 Water and Sewerage Facilities

3.7.1 Overview.

Water: The Metropolitan District Commission (MDC) is responsible for the care and control of the reservoirs and all water rights in the study area. MDC wholesales the water for distribution to the Massachusetts Water Resources Association (MWRA), an organization created in 1984 to control all sewer and water distribution. MWRA in turn wholesales water to the communities, who then retail it to consumers.

The MWRA service within the study area includes Marblehead to the north and east; Quincy and Dedham to the south; and Lexington and Woburn to the west (essentially the entire study area). Service to Boston proper is controlled by the Boston Water and Sewer Commission, but the Commission deals through the MWRA.

The water for the Boston area originates in the Quabbin Reservoir, 65 miles west of Boston. From Quabbin, the flow is sent by gravity through a series of aqueducts and tunnels, which also carry supplies from other smaller reservoirs along the way. The Hultman Aqueduct brings water into the study area, where it runs into the 3-mile Southborough Tunnel and completes the trip into the Boston area, carrying the flow 18 miles to the City Tunnel in Newton, which brings the water into the district. Two other conduits supplement the Hultman Aqueduct as needed.

The delivery system's major link leading into the heart of the study area is the 5-mile City Tunnel, a deep rock facility, 12 feet in diameter, connecting Hultman Aqueduct's terminal shaft at the Charles River in Newton with Chestnut Hill. Links to large distribution mains are here to convey water to several communities. A 10-foot City Tunnel offshoot extends 7.1 miles from Chestnut Hill to Malden, serving most of the communities north of Boston. The Dorchester Tunnel, a 10-foot-deep rock tunnel runs 6.6 miles from the City Tun-

nel at Chestnut Hill to the Boston-Milton line at Dorchester Lower Hills. Aqueducts and tunnels in the study area are listed in Table 3.7b.

Six water distribution systems are required to serve the cities and towns of this water district because of their various elevations. These systems are supplied by aqueducts, pumping, and distribution storage facilities.

The systems have a network of approximately 250 miles of water mains, ranging from 16 to 60 inches in diameter. The Metropolitan Water District has 14 distribution reservoirs. The largest distribution reservoir in the study area is the 290-acre Spot Pond in Cell 2, with a capacity of 1,838 million gallons. Another major distribution reservoir is the Chestnut Hill Reservoir (523 million gallons) in Cell 6. Reservoirs and storage facilities are listed in Tables 3.7c and 3.7d, respectively.

The district operates 12 pumping stations, with the largest located at the two reservoirs mentioned above. Table 3.7a details the pumping stations in the study area. The pressure controls are listed in Table 3.7e.

Treatment of the water in the district is confined to small amounts of chlorine and ammonia as water enters distribution lines. Several communities in the surrounding area that do not receive their water from MDC/MWRA have water treatment plants in the Boston area. These treatment plants are listed in Table 3.7f.

Severage System: MWRA administers the Metropolitan Severage District (MSD) in the study area. Two operating systems (one in the north at Deer Island and one in the south at Nut Island) serve Boston and the surrounding communities.

Each operating system has five pumping stations, a treatment plant, and five outfalls in the Boston Harbor. In the north, wastewater is transported by gravity and the five pumping stations to the Nut Island Wastewater Treatment Plant in Quincy. This plant has been operating since 1952. The pumps are driven by 200-horsepower electric motors. The prime source of power for the plant is its own generating station, with a backup and alternate from Massachusetts Electric. Of the five outfalls from Nut Island, one is used to discharge digested sludge, and the other four are for effluent. The average flow for the Nut Island Treatment Plant and its outfall is 124 million gallons of sewage per 24 hours.

In the south, wastewater is also transported by gravity and five pumping stations to Deer Island Treatment Plant in Winthrop. Operating since 1968, the Deer Island plant is totally dependent on its own power generation. The power plant consists of five diesel engines driving 875-kVA, 700-kW, 2400/4160-V, 3-phase, 60-Hz alternators. Of the five outfalls discharging sewage from Deer Island, only two are generally in use. The other three are reserved for temporary use. The average flow from this treatment plant and outfalls is 295 million gallons of sewage per 24 hours.

Three headworks lead to deep rock tunnels in Roxbury, South Boston, and Chelsea. All of them contain 200-kW emergency generator sets. A fourth headwork is located on Deer Island for preliminary treatment of severage. In addition to its ten pumping stations (Table 3.7a), two treatment plants (Table 3.7f), ten outfalls (Table 3.7i), and four headworks, the district also contains three stormwater detention or chlorination stations. The three temporary outfalls at the MWRA Deer Island sewage treatment plant are not included in Table 3.7i.

Saugus, Lynn, Salem, Swampscott, and Marblehead are communities within the study area that are not part of the MSD. These communities have their own severage network

Inventory of the sewerage system pressure controls, metering stations, and interceptors is detailed in Tables 3.7e, 3.7g, and 3.7h, respectively.

3.7.2 Engineering Classifications and Replacement Values. Engineering structure classifications and replacement values are indicated by cell groupings and seismic hazard zones for water systems in Table 3.7j and for sewerage facilities in Table 3.7k.

In accordance with the methodology discussed in Chapter 4, the damage of pipelines is reported in terms of breaks per mile. Therefore, the replacement value tables report pipelines in terms of total miles rather than cost.

TABLE 3.7a

WATER AND SEWERAGE UTILITIES

PUMPING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
PS 1	ARLINGTON	ARLINGTON PUMP STATION	BRATTLE @ BRATTLE CT.	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 2	BELMONT	BELMONT PUMP STATION	PLEASANT ST. @ ALEXANDER	M.W.R.A.	WATER	MAIN PUMP STATION			3
PS 3	BOSTON	HYDE PARK PUMP STATION	HYDE PARK AVE.@ DALE ST.@	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 4	BROOKLINE	BROOKLINE PUMP STATION	GROVE @ NEWTON ST.	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 5	CAMBRIDGE	WATER TREATMENT PLT.	FRESH POND	CAMBRIDGE WATER	WATER	HORIZ.,CENTRIFUGAL	3 PUMPS, LOW & HIGH LIFT	1922	3
PS 6	LYNN	BLOSSOM ST.	BLOSSOM ST.	LYNN W.& S.COMM	SEWER	SUBMERSIBLE PUMP	2 @ 1.5HP	1976	3
PS 7	LYNN	CAMDEN ST.	CAMDEN & RIVER ST.	LYNN W.& S.COMM	SEWER	CONCRETE DRYWELL	500GPM		3
PS 8	LYNN	GLENLEWIS DAM	WALDEN POND	LYNN W.& S.COMM	WATER	FORCE MAIN	20MGD	1912	3
PS 9	LYNN	HARBOR HOUSE	LYNNWAY @ HANSON ST.	LYNN W.& S.COMM	SEWER	SUBMERSIBLE PUMP	2 @ 5HP	1978	3
PS 10	LYNN	HOLLIS RD.	HOLLIS RD.	LYNN W.& S.COMM	SEWER	UNDERGROUND	2 @ 5HP	1976	1
PS 11	LYNN	LAKESIDE AVE.	LAKESIDE AVE.	LYNN W.& S.COMM	SEWER	SUBMERSIBLE PUMP	2 @ 125GPM	1921	3
PS 12	LYNN	LOG CABIN RD.	LOG CABIN RD.	LYNN W.& S.COMM	SEWER	EFFLUENT PUMP	2 @ 125GPM	1986	1
PS 13	LYNN	LOW LIFT PUMP STAT.	DUNGEON AVE.	LYNN W.& S.COMM	WATER	UNDER CONSTRUCTION	19.5MGD		1
PS 14	LYNN	MAIN PUMP STATION	WALNUT ST.	LYNN W.& S.COMM	WATER	L-SERVICE FORCE MAIN	2 L-S & 2 H-S PUMPS	1871	2
PS 15	LYNN	OUTFALL PUMPING ST.	GAS WHARF RD.	LYNN W.& S.COMM	SEWER	HYDRAULIC	60MGD	1925	3
PS 16	LYNN	QUINN RD.BOOSTER	QUINN RD.	LYNN W.& S.COMM	WATER	BOOSTER PUMP		1963	1
PS 17	LYNN	REED ST.	REED ST.	LYNN W.& S.COMM	SEWER	CONCRETE SUB.,BRICK	2 @ 125GPM	1926	2
PS 18	LYNN	SANDERSON AVE.	SANDERSON AVE.	LYNN W.& S.COMM	SEWER	DRYWELL,A-GRD.BRICK	2 @ 7.5HP		1
PS 19	LYNN	TRANFLAGIA AVE.	TRANFLAGIA AVE.	LYNN W.& S.COMM	SEWER	SUBMERSIBLE PUMP	2 @ 300GPM	1958	2
PS 20	LYNN	WASHINGTON ST.	WASHINGTON	LYNN W.& S.COMM	SEWER	CONCRETE SUBSTRUC.	2 @ 1600GPM,1 @ 3000GPM	1909	1
PS 21	MARBLEHEAD	OUTFALL PUMP STATION	SARGENT RD.	S.E.S.D.	SEWER	PUMP STATION			3
PS 22	MARBLEHEAD	S.E.S.D.PUMP STATION	GILBERTHS @ OCEAN	S.E.S.D.	SEWER	PUMP STATION			3
PS 23	NAHANT	LAFAYETTE TERRACE	LAFAYETTE TERRACE	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 24	NAHANT	LOWLANDS PUMP STAT.	LOWLANDS	LYNN W.& S.COMM	SEWER	LIFT STATION			2
PS 25	NAHANT	MAOLIS ST.	MAOLIS ST.	LYNN W.& S.COMM	SEWER				1
PS 26	NAHANT	NAHANT RD.	NAHANT RD.	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 27	NAHANT	PEARL RD.	PEARL RD.	LYNN W.& S.COMM	SEWER	LIFT STATION			2
PS 28	NAHANT	RANGE RD.	RANGE RD.	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 29	NAHANT	ROLLINS AVE.	ROLLINS AVE.	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 30	NAHANT	WHARF LANE	WHARF LANE	LYNN W.& S.COMM	SEWER	LIFT STATION			1

TABLE 3.7a (cont.)

WATER AND SEWERAGE UTILITIES

PUMPING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
PS 31	NAHANT	WHARF ST.	WHARF ST.	LYNN W.& S.COMM	SEWER				1
PS 32	NAHANT	WHITE WAY	WHITE WAY	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 33	NAHANT	WINTER ST.	WINTER ST.	LYNN W.& S.COMM	SEWER	LIFT STATION			1
PS 34	NEWTON	CHESTNUT HILL RESERVOIR #1,#2	CHESTNUT HILL RESERVOIR	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 35	NEWTON	DUDLEY ST. PUMP STATION	DUDLEY ST @ BOYLSTON ST.	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 36	NEWTON	NEWTON PUMP STATION	COMMONWEALTH AVE.	M.W.R.A.	WATER	MAIN PUMP STATION			2
PS 37	SALEM	PEABODY-SALEM	FORT AVE.	S.E.S.D.	SEWER	EFFLUENT			1
PS 38	SALEM	PEABODY-SALEM (NEW)	FORT AVE. @ VICTORY	S.E.S.D.	SEWER	INFLUENT			3
PS 39	SAUGUS	HAWKES POND	HAWKES POND, SAUGUS	LYNN W.& S.COMM	WATER		20MGD	1920	2
PS 40	STONEHAM	SPOT POND PUMP STATION	WOODLAND RD. @ RAVINE RD.	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 41	SWAMPSCOTT	1.HUMPHREY ST.	HUMPHREY ST.	SWAMPSCOTT S.D.	SEWER				1
PS 42	SWAMPSCOTT	2.LITTLE POINT RD.	near LITTLE POINT RD.	SWAMPSCOTT S.D.	SEWER				1
PS 43	SWAMPSCOTT	3.ROCKYLEDGE RD.	ROCKYLEDGE RD.	SWAMPSCOTT S.D.	SEWER				1
PS 44	WAKEFIELD	BAY STATE RD.	BAY STATE RD. @ RTE128	WAKEFIELD P.W.	SEWER		100GPM	1975	3
PS 45	WAKEFIELD	BROADWAY	BROADWAY ST. @ LAKE ST.	WAKEFIELD P.W.	WATER		2.5MGD	1927	1
PS 46	WAKEFIELD	CENTRAL ST.	CENTRAL ST. @ MAIN ST.	WAKEFIELD P.W.	SEWER		100GPM	1930	1
PS 47	WAKEFIELD	FARM ST.	FARM ST. @ WATER ST.	WAKEFIELD P.W.	SEWER		420GPM	1969	1
PS 48	WAKEFIELD	FINDLAY ST.	FINDLAY ST. @ GRAFTON	WAKEFIELD P.W.	SEWER		200GPM	1982	1
PS 49	WAKEFIELD	JENNIFER RD.	W.PARK DR. @ JENNIFER	WAKEFIELD P.W.	SEWER		100GPM	1970	1
PS 50	WAKEFIELD	LAKEVIEW AVE.	LAKEVIEW AVE.	WAKEFIELD P.W.	SEWER		75GPM	1982	1
PS 51	WAKEFIELD	LINDEN ST.	LINDEN ST.	WAKEFIELD P.W.	WATER	3 PUMPS	750GPM,2000GPM,4000GPM	1958	1
PS 52	WAKEFIELD	PLAZA RD.	PLAZA RD.	WAKEFIELD P.W.	SEWER		50GPM	1971	1
PS 53	WAKEFIELD	PROSPECT ST.	PROSPECT ST.	WAKEFIELD P.W.	SEWER	ABANDONED			1
PS 54	WAKEFIELD	SPAULDING ST.	oppo. SPAULDING ST.	WAKEFIELD P.W.	SEWER		100GPM	1948	2
PS 55	WALTHAM	LEXINGTON ST. PUMP STATION	LEXINGTON ST. @ PLYMPTON	M.W.R.A.	WATER	MAIN PUMP STATION			1
PS 56	WINCHESTER	1.WEST HIGH LIFT STATION	THORNBERRY RD.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	50GPM		1
PS 57	WINCHESTER	2.WEST HIGH LIFT STATION	SQUIRE RD.	WINCHESTER P.W.	SEWER	STEEL,CENTRIFUGAL	750GPM		1
PS 58	WINCHESTER	3.WEST HIGH LIFT STATION	PEPPER HILL DR.	WINCHESTER P.W.	SEWER	STEEL,CENTRIFUGAL	150GPM		1
PS 59	WINCHESTER	4.WEST HIGH LIFT STATION	AMBERWOOD DR.	WINCHESTER P.W.	SEWER	STEEL,CENTRIFUGAL	150GPM		1
PS 60	WINCHESTER	5.WEST HIGH LIFT STATION	LONGFELLOW RD.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	50GPM		1

TABLE 3.7a (cont.)
WATER AND SEWERAGE UTILITIES
PUMPING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
PS 61	WINCHESTER	6.WEST HIGH LIFT STATION	WOODSIDE RD.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	50GPM		2
PS 62	WINCHESTER	7.MIDDLE LOW LIFT STATION	PALMER ST.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	30GPM		1
PS 63	WINCHESTER	8.EAST HIGH LIFT STATION	ROBINSON ST.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	40GPM		3
PS 64	WINCHESTER	9.EAST HIGH LIFT STATION	CLEARWATER RD.	WINCHESTER P.W.	SEWER	PNEUMATIC EJECTOR	30GPM		3
PS 65	WINCHESTER	NORTH PUMP STATION	NORTH BORDER ST.	WINCHESTER P.W.	WATER	EAST HIGH & MID.LOW	850GPM, 550GPM		1
PS 66	WINCHESTER	RISLEY RD.	RISLEY RD.	WINCHESTER P.W.	WATER	EAST HIGH	850GPM		1
PS 67	WINCHESTER	SPOT POND	MIDDLE RESERVOIR	WINCHESTER P.W.	WATER		6MGD		2
PS 68	WINCHESTER	WINCHESTER DEPT. of PUB.WKS.	15 LAKE ST.	WINCHESTER P.W.	SEWER	6 PORTABLE PUMPS			1
PS 69	WOBURN	1.	DIX RD. @ LEXINGTON RD.	WOBURN PUB.WKS.	SEWER				1
PS 70	WOBURN	2.	DRAPER ST @ NASHUA BLVD.	WOBURN PUB.WKS.	SEWER				2
PS 71	WOBURN	3.	BRIARWOOD @ WINTER ST.	WOBURN PUB.WKS.	SEWER				1
PS 72	WOBURN	4.	BELMONT @ GARFIELD ST.	WOBURN PUB.WKS.	SEWER				2
PS 73	WOBURN	5.	BRADFORD RD @ GARFIELD	WOBURN PUB.WKS.	SEWER				1
PS 74	WOBURN	6.	WALNUT HILL PARK	WOBURN PUB.WKS.	SEWER	FORCE MAIN, PRIVATE			2
PS 75	WOBURN	A2	HORN POND @ POND ST.	WOBURN PUB.WKS.	WATER	WELL		1952	2
PS 76	WOBURN	B	HORN POND @ POND ST.	WOBURN PUB.WKS.	WATER	WELL		1950	2
PS 77	WOBURN	C2	HORN POND @ POND ST.	WOBURN PUB.WKS.	WATER	WELL		1950	2
PS 78	WOBURN	D	HORN POND @ WOBURN PKWY.	WOBURN PUB.WKS.	WATER	WELL		1930	2
PS 79	WOBURN	E	LEXINGTON ST.	WOBURN PUB.WKS.	WATER	WELL		1950	3
PS 80	WOBURN	F	WATER ST.	WOBURN PUB.WKS.	WATER	WELL		1950	3
PS 81	WOBURN	G	ABERJONA R.VALLEY	WOBURN PUB.WKS.	WATER	WELL	NON-OPERATIONAL	1979	2
PS 82	WOBURN	H	ABERJONA R.VALLEY	WOBURN PUB.WKS.	WATER	WELL	NON-OPERATIONAL	1979	2
PS 83	WOBURN	I	HORN POND @ WEST SHORE	WOBURN PUB.WKS.	WATER	WELL		1986	3
PS 84	WOBURN	MAIN PUMP ST.	HORN POND @ POND ST.	WOBURN PUB.WKS.	WATER		1MGD		3
PS 85	WOBURN	P	US.RTE3	WOBURN PUB.WKS.	SEWER	FORCE MAIN, PRIVATE	6"		1
PS 86	WOBURN	PUMP STATION 1.	RUSSELL @ CAMBRIDGE	WOBURN PUB.WKS.	WATER	REPUMP STATION	1000000G.		1
PS 87	WOBURN	PUMP STATION 2.	BLUEBERRY HILL RD.	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			2
PS 88	WOBURN	PUMP STATION 3.	HIAWATHA RD.	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			1
PS 89	WOBURN	PUMP STATION 4.	SHERMAN PL.	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			1
PS 90	WOBURN	PUMP STATION 5	INGALLS ST.	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			1

TABLE 3.7a (cont.)
WATER AND SEWERAGE UTILITIES
PUMPING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
PS 91	WOBURN	PUMP STATION 6.	HILLTOP TERRACE	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			2
PS 92	WOBURN	PUMP STATION 7.	CEDARWOOD RD.	WOBURN PUB.WKS.	WATER	SECONDARY PUMP			1
PS 93	BOSTON	CALF PASTURE PUMPING STATION	MT.VERNON ST.	B.W.S.C.	SEWER		>72" DIAMETER PIPE		3
PS 94	BOSTON	UNION PARK PUMPING STATION	UNION PARK ST.	B.W.S.C.	SEWER				3
PS 95	BEDFORD		HARVARD DR.	BEDFORD P.W.	SEWER				3
PS 96	BEDFORD		BIRCHWOOD RD.	BEDFORD P.W.	SEWER				1
PS 97	BEDFORD	NO. 7,8,9	MIDDLESEX TURNPIKE, ext.	BEDFORD P.W.	WATER	WELL, (3)			3
PS 98	BEDFORD	NO. 3	BURLINGTON RD.	BEDFORD P.W.	WATER	WELL			1
PS 99	BEDFORD		MIDDLESEX TURNPIKE	BEDFORD P.W.	SEWER				1
PS100	BEDFORD		BURLINGTON RD.	BEDFORD P.W.	SEWER				1
PS101	BEDFORD	NO.10,11	HARTWELL RD.	BEDFORD P.W.	WATER	WELL			3
PS102	BEDFORD	NO.12	HARTWELL RD.	BEDFORD P.W.	WATER	WELL			3
PS103	BEDFORD	NO.2,4	SHAWSHEEN RD.	BEDFORD P.W.	WATER	WELL			3
PS104	BEDFORD	NO.5,6	SHAWSHEEN RD.	BEDFORD P.W.	WATER	WELL			3
PS105	BEDFORD	NO.1	OLD BILLERICA RD.	BEDFORD P.W.	WATER	WELL			3
PS106	BEDFORD		LYNNFIELD @ GENETTI	BEDFORD P.W.	SEWER				3
PS107	BEDFORD		HARTWELL RD.	BEDFORD P.W.	SEWER				3
PS108	BEDFORD		WASHINGTON ST., ext.	BEDFORD P.W.	SEWER				3
PS109	BEDFORD		WASHINGTON ST. @ BEACON	BEDFORD P.W.	SEWER				3
PS110	BEDFORD		SOUTH RD.	BEDFORD P.W.	SEWER				3
PS111	BEDFORD		SHAWSHEEN RD. @ GREAT RD.	BEDFORD P.W.	SEWER				3
PS112	BEDFORD		CEDAR RIDGE @ RIDGE RD.	BEDFORD P.W.	SEWER				3
PS113	BEDFORD		near PAGE RD.	BEDFORD P.W.	SEWER				3
PS114	BEDFORD		PARKER RD.	BEDFORD P.W.	SEWER				3
PS115	BEDFORD		BONNIEVALLE DR.	BEDFORD P.W.	SEWER				3
PS116	BEDFORD		NORMA RD.	BEDFORD P.W.	SEWER				3
PS117	BEDFORD		HILLCREST near DAVIS RD.	BEDFORD P.W.	SEWER				3
PS118	BEDFORD		EVANS AVE.	BEDFORD P.W.	SEWER				3
PS119	BEDFORD		NOTH RD., ext.	BEDFORD P.W.	SEWER				1
PS120	BEDFORD		KIDDER LN.	BEDFORD P.W.	SEWER				1

TABLE 3.7a (cont.)
WATER AND SEWERAGE UTILITIES
PUMPING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
PS121	BEDFORD		WINCHESTER LN.	BEDFORD P.W.	SEWER				1
PS122	BEDFORD		WILSON RD. @ HUME RD.	BEDFORD P.W.	SEWER				1
PS123	LEXINGTON		MASSACHUSETTS AVE.	LEWINGTON P.W.	SEWER				2
PS124	LEXINGTON		CONSTITUTION	LEXINGTON P.W.	SEWER				1
PS125	LEXINGTON		NORTHERN CIRCUM. HWY.	LEXINGTON P.W.	SEWER				3
PS126	LEXINGTON		MARSHALL RD.	LEXINGTON P.W.	SEWER				1
PS127	LEXINGTON		WORTHEN RD.	LEXINGTON P.W.	SEWER				2
PS128	LEXINGTON		BRIGHAM RD.	LEXINGTON P.W.	SEWER				2
PS129	LEXINGTON		NORTH ST. @ ADAMS	LEXINGTON P.W.	SEWER				2
PS130	LEXINGTON		HAYDEN AVE.	LEXINGTON P.W.	SEWER				2
PS131	LEXINGTON		CONCORD AVE.	LEXINGTON P.W.	SEWER				3
PS132	LEXINGTON		CONCORD AVE.	LEXINGTON P.W.	SEWER				1
PS133	LEXINGTON		BYRON AVE. @ ROCKWOOD RD.	LEXINGTON P.W.	SEWER				2
PS134	ARLINGTON	ALEWIFE BROOK PUMP STATION	near GORDON ST.	M.S.D.	SEWER	MAIN PUMP STATION	8-205MGD		3
PS135	BOSTON	CHARLESTOWN PUMP STATION	near SPICE ST.	M.S.D.	SEWER	MAIN PUMP STATION	8-205MGD		3
PS136	BOSTON	EAST BOSTON (STEAM & ELECTRIC)	near CURTIS ST.	M.S.D.	SEWER	MAIN PUMP STATION	(2) @ 8-205MGD		3
PS137	MELROSE		HOWARD @ WINDSOR, ext.	MELROSE P.W.	SEWER				1
PS138	MELROSE		PENNY RD.	MELROSE P.W.	SEWER				1
PS139	MELROSE		UPHAM near WILLOW RD.	MELROSE P.W.	SEWER				1
PS140	QUINCY	BRAINTREE-WEYMOUTH	SEA ST.	M.S.D.	SEWER	MAIN PUMP STATION	2.8-60MGD		3
PS141	QUINCY	QUINCY PUMP STATION	ESTABROOK RD.	M.S.D.	SEWER	MAIN PUMP STATION	2.8-60MGD		3
PS142	QUINCY	SQUANTUM PUMP STATION	EAST SQUANTUM ST.	M.S.D.	SEWER	MAIN PUMP STATION	2.8-60MGD		3
PS143	QUINCY	HOUGH'S NECK PUMPING STATION	STOUGHTON AVE.	M.S.D.	SEWER	MAIN PUMP STATION	2.8-60MGD		3
PS144	QUINCY	NUT ISLAND TREATMENT PLANT	TAFTS AVE.	M.S.D.	SEWER	MAIN PUMP STATION	334MGD		3
PS145	WINTHROP	DEER ISLAND TREATMENT PLANT	ISLAND AVE.	M.S.D.	SEWER	MAIN PUMP STATION	810MGD		2

TABLE 3.7b
WATER AND SEWERAGE UTILITIES
AQUEDUCTS & TUNNELS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
W 1	BOSTON	TUNNEL	ADAMS ST.- AMERICAN LEGION HWY. @ MORTON	TUNNEL				3
W 2	BOSTON	TUNNEL	AM.LEG.HWY.@ MORTON - CHESTNUT HILL RES.	TUNNEL				3
W 3	CAMBRIDGE	FRESH POND WEIR	FRESH POND - HOLMES ST.	TUNNEL	CONCRETE, 1000'LONG	63" DIAM.	1887	3
W 4	CAMBRIDGE	TUNNEL	HOLWORTHY ST. - RIVER	TUNNEL	CONCRETE, 25900'LONG	63" DIAM.	1887	3
W 5	MALDEN	TUNNEL	WESTERN AVE.- MEDFORD ST. @ MIDDLESEX	TUNNEL				3
W 6	NEWTON	TUNNEL	CHESTNUT HILL RES.- CHARLES RIVER	TUNNEL				2
W 7	NEWTON	TUNNEL	CHESTNUT HILL RES.- WESTERN AVE.	TUNNEL				3
W 8	NEWTON	SUDBURY AQUEDUCT	NEWTON CEMETERY- near CHARLES RIVER AVE.	AQUEDUCT				2
W 9	SAUGUS	TUNNEL	WALDEN - BIRCH POND	TUNNEL			1890	1
W10	WALTHAM	HOBBS-STONY BROOK	WINTER ST.	AQUEDUCT	2.5MI. OPEN CHANNEL	2.7568G	1897	2
W11	BOSTON	BOSTON MAIN DRAINAGE TUNNEL	WARD ST. - COLOMBUS PARK - DEER ISLAND	TUNNEL	7 MILE SEWER TUNNEL		1950	3
W12	BOSTON	NORTH METROPOLITAN RELIEF	EAST BOSTON PUMP STATION - DEER ISLAND	TUNNEL	4 MILE SEWER TUNNEL			3

TABLE 3.7c

WATER AND SEWERAGE UTILITIES

WATER RESERVOIRS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	FACILITY CLASSIFICATION	RESERVOIR CAPACITY	BACKUP POWER	YEAR BUILT	SEISMIC HAZARD
RES 1	ARLINGTON	ARLINGTON RESERVOIR	EUSTIS @ GLENBURN	M.W.R.A.					1
RES 2	BOSTON	BELLEVUE RESERVOIRS, 1 & 2	WEST ROXBURY PKWY.	M.W.R.A.					1
RES 3	BROOKLINE	BROOKLINE RESERVOIR	BOYLSTON @ LEE	M.W.R.A.					1
RES 4	BROOKLINE	FISHER HILL RESERVOIR	FISHER AVE. @ LEICESTER	M.W.R.A.					1
RES 5	CAMBRIDGE	FRESH POND RESERVOIR	CAMBRIDGE	CAMBRIDGE WATER	NATURAL	1308MG		1853	3
RES 6	LYNN	BIRCH POND	SAUGUS-LYNN border	LYNN W.& S.COMM	EARTH-FILLED DAM	340MG		1873	1
RES 7	LYNN	BREEDS POND	north of WALNUT ST.	LYNN W.& S.COMM	EARTH-FILLED DAM	1570MG		1870	1
RES 8	LYNN	LOW SERVICE RESERVOIR	SUNNYSIDE RD.	LYNN W.& S.COMM		14MG		1872	1
RES 9	LYNN	WALDEN POND	NW.LYNN	LYNN W.& S.COMM	CONCRETE CORE WALL	1700MG		1889	3
RES10	MEDFORD	MIDDLE RESERVOIR	MIDDLESEX FELLS RESERVOIR	WINCHESTER P.W.	NATURAL	58 ACRES SURFACE AREA	NO		2
RES11	MEDFORD	SOUTH RESERVOIR	MIDDLESEX FELLS RESERVOIR	WINCHESTER P.W.	NATURAL	81 ACRES SURFACE AREA			2
RES12	NEWTON	CHESTNUT HILL RESERVOIR	BEACON ST.	M.W.R.A.					1
RES13	NEWTON	WABAN HILL RESERVOIR	STUART ST. @ MANET RD.	M.W.R.A.					1
RES14	QUINCY	BLUE HILL RESERVOIR	BLUE HILLS RESERVATION	M.W.R.A.					1
RES15	QUINCY	FORBES HILL RESERVOIR	SUMMIT @ RESERVOIR RD.	M.W.R.A.					1
RES16	REVERE	REVERE RESERVOIR	TUDOR ST. @ PROSPECT ST.	M.W.R.A.					2
RES17	SALEM	PEABODY RESERVOIR	SALEM	S.E.S.D.		219'			1
RES18	SAUGUS	HAWKES POND	US.RTE 1 & US.RTE 128	LYNN W.& S.COMM	EARTH-FILLED DAM	180MG		1895	3
RES19	STONEHAM	BEAR HILL RESERVOIR	MIDDLESEX FELLS RESERVOIR	M.W.R.A.					1
RES20	STONEHAM	FELLS RESERVOIR	FELLSWAY EAST	M.W.R.A.					1
RES21	STONEHAM	SPOT POND	WOODLAND RD. @ POND ST.	M.W.R.A.					2
RES22	WAKEFIELD	CRYSTAL LAKE		WAKEFIELD P.W.		300MG			1
RES23	WALTHAM	HOBBS BROOK	CAMBRIDGE RESERVOIR	CAMBRIDGE WATER	EARTHERN DAM	2756MG		1897	2
RES24	WALTHAM	STONY BROOK	CHARLES RIVER	CAMBRIDGE WATER	EARTHERN DAM	387MG		1887	1
RES25	WINCHESTER	NORTH RESERVOIR	HILLCREST PKWY.	WINCHESTER P.W.	NATURAL	59 ACRES SURFACE AREA	NO		1

TABLE 3.7d

WATER AND SEWERAGE UTILITIES

WATER STORAGE FACILITIES

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	CLASSIFICATION	CAPACITY	YEAR BUILT	SEISMIC HAZARD
S 1	ARLINGTON	ARLINGTON STANDPIPE	PARK CIRCLE	STANDPIPE				1
S 2	ARLINGTON	TURKEYHILL STANDPIPE	RIDGE RD.	STORAGE		650000G		1
S 3	BELMONT	PAYSON PARK	BELMONT	STORAGE	GRANITE,EARTH	43MG		2
S 4	CAMBRIDGE	FRESH POND WEIR	FRESH POND	STORAGE	U-GRD.CONCRETE	4MG	1853	3
S 5	LEXINGTON	WALNUT HILL STANDPIPE	PLEASANT ST. @ STERNS RD.	STANDPIPE				1
S 6	LYNN	DIBBLE RD. STANDPIPE	DIBBLE RD.	STORAGE	STEEL ON GROUND	.6MG	1968	1
S 7	LYNN	LYNN WOODS TANK	STANDPIPE RD.	STORAGE	CONCRETE ON GROUND	3.5MG	1972	1
S 8	LYNN	PINE HILL TANK	PRESTON ST.	STORAGE	CONCRETE ON GROUND	2.8MG	1973	1
S 9	LYNN	QUINN RD. STANDPIPE	QUINN RD.	STORAGE	ELEV.STEEL TANK	.5MG	1958	1
S10	MEDFORD	SOUTH STANDPIPE	near JEFFERSON RD.	STORAGE	STEEL ABOVE GROUND	47000G		1
S11	QUINCY	FORBES HILL STANDPIPE	SUMMIT @ RESERVOIR	STANDPIPE				1
S12	STONEHAM	GREEN ST.	GREEN ST.	STANDPIPE			1920	1
S13	SWAMPSCOTT	S.W.W. STANDPIPE	PLYMOUTH LANE	STORAGE				1
S14	WAKEFIELD	SIDNEY ST.STANDPIPE	SIDNEY ST. @ UPLAND RD.	STORAGE	STEEL,ABOVE GROUND	650000G	1927	1
S15	WINCHESTER	NORTH STANDPIPE	HILLCREST PKWY.	STORAGE	STEEL,ABOVE GROUND	376000G		1
S16	WINCHESTER	RISLEY ROAD	RISLEY RD.	STORAGE				1
S17	WOBURN	1.WATER TANK	POND ST.	STORAGE	OPEN,ROCK,MANMADE	100000G	1880	1
S18	WOBURN	2.WATER TANK	WALTHAM ST. @ GRACE RD.	STORAGE	COVERED CONCRETE	250000G	1950	1
S19	WOBURN	3.WATER TANK	north of BATTLE MARCH WY.	STORAGE	COVERED CONCRETE	4000000G	1960	1
S20	WOBURN	4.WATER TANK	near HILLSIDE AVE.	STORAGE	COVERED SHELL	4400000G	1960	2
S21	WOBURN	LIQ.CHLORINE STATION	WOBURN PKWY. @ POND ST.	STORAGE		100G	1980	1
S22	BEDFORD	TANK 1,2	FLETCHER RD.,ext.	STORAGE		700000G		1
S23	BEDFORD	TANK 3	CROSBY DR.	STORAGE		560000G		1
S24	BEDFORD	TANK 4	REEVES RD. @ AVON RD.	STORAGE		550000G		1

TABLE 3.7e

WATER AND SEWERAGE UTILITIES

WATER PRESSURE CONTROLS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	SEISMIC HAZARD
PC 1	ARLINGTON	MEDFORD ST. REGULATOR	MEDFORD ST. @ MASSACHUSETTS AVE.	M.W.R.A.	REGULATOR	3
PC 2	ARLINGTON	PRESSURE GAUGE	MASSACHUSETTS AVE. @ HIBBERT ST.	M.W.R.A.	PRESSURE GAUGE	1
PC 3	BELMONT	PAYSON PARK	BELMONT	CAMBRIDGE WATER	PRESS. CONTROL	2
PC 4	BELMONT	COMMON ST. PRESSURE GAUGE	COMMON ST. near PAYSON RD.	M.W.R.A.	PRESSURE GAUGE	1
PC 5	BELMONT	PLEASANT ST. REGULATOR	PLEASANT ST. @ SNAKE HILL RD.	M.W.R.A.	REGULATOR	1
PC 6	BOSTON	ALLSTON FIRE STATION	HARVARD AVE.	M.W.R.A.	PRESSURE GAUGE	3
PC 7	BOSTON	LAKE ST. PRESSURE GAUGE	COMMONWEALTH AVE. @ LAKE ST.	M.W.R.A.	PRESSURE GAUGE	2
PC 8	BOSTON	NORTH BEACON ST. REGULATOR, 2	NO.BEACON ST. @ SOLDIERS FIELD RD.	M.W.R.A.	REGULATOR	3
PC 9	BROOKLINE	CHESTNUT HILL REGULATOR, 2	CHESTNUT HILL RESERVOIR	M.W.R.A.	REGULATOR	3
PC10	CAMBRIDGE	MASSACHUSETTS AVE. REGULATOR	MASSACHUSETTS AVE. @ KIRKLAND	M.W.R.A.	REGULATOR	3
PC11	CAMBRIDGE	NORFOLK ST. REGULATOR	NORFOLK ST. @ HARVARD	M.W.R.A.	REGULATOR	3
PC12	CHELSEA	CHELSEA FIRE STATION	CHELSEA SQ.	M.W.R.A.	PRESSURE GAUGE	3
PC13	CHELSEA	WASHINGTON ST. PRESSURE GAUGE	WASHINGTON ST. near COOK AVE.	M.W.R.A.	PRESSURE GAUGE	2
PC14	EVERETT	PRESSURE GAUGE	WINTHROP @ NORWOOD	M.W.R.A.	PRESSURE GAUGE	2
PC15	LYNN	EASTERN AVE. REGULATOR	EASTERN AVE. @ OCEAN AVE.	M.W.R.A.	REGULATOR	1
PC16	LYNN	LYNN FIRE STATION	LYNNWAY near KINGMAN ST.	M.W.R.A.	PRESSURE GAUGE	3
PC17	MALDEN	PRESSURE GAUGE	HIGHLAND AVE. @ CLIFTON ST.	M.W.R.A.	PRESSURE GAUGE	1
PC18	MEDFORD	PRESSURE GAUGE	RIVERSIDE AVE. near GOVERNOR'S	M.W.R.A.	PRESSURE GAUGE	3
PC19	MILTON	PRESSURE GAUGE	ADAMS near CANTON	M.W.R.A.	PRESSURE GAUGE	1
PC20	NEWTON	REGULATOR	WILLIAM @ CENTRE	M.W.R.A.	REGULATOR	3
PC21	QUINCY	FORBES HILL BLDG.	SUMMIT AVE.	M.W.R.A.	PRESSURE GAUGE	1
PC22	REVERE	BROADWAY PRESSURE GAUGE	BROADWAY near CENTRAL AVE.	M.W.R.A.	PRESSURE GAUGE	3
PC23	REVERE	REGULATOR	RESERVATION @ LYNNWAY	M.W.R.A.	REGULATOR	3
PC24	REVERE	REGULATOR	WINTHROP @ REVERE BEACH PKWY.	M.W.R.A.	REGULATOR	1
PC25	REVERE	REVERE BEACH REGULATOR	REVERE BEACH AVE. @ MILL ST.	M.W.R.A.	REGULATOR	3
PC26	REVERE	REVERE BEACH REGULATOR	REVERE BEACH AVE. @ REVERE ST.	M.W.R.A.	REGULATOR	3
PC27	REVERE	REVERE BEACH REGULATOR	REVERE BEACH AVE. @ WEBSTER	M.W.R.A.	REGULATOR	1
PC28	REVERE	REVERE RESERVOIR REGULATOR	TUDOR ST. @ PROSPECT AVE.	M.W.R.A.	REGULATOR	2
PC29	REVERE	WINTHROP AVE. PRESSURE GAUGE	WINTHROP AVE. @ WINTHROP PKWY.	M.W.R.A.	PRESSURE GAUGE	3
PC30	REVERE	WINTHROP AVE. REGULATOR	WINTHROP AVE. @ WEBSTER	M.W.R.A.	REGULATOR	1

TABLE 3.7e (cont.)
WATER AND SEWERAGE UTILITIES
WATER PRESSURE CONTROLS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	SEISMIC HAZARD
PC31	SOMERVILLE	BROADWAY REGULATOR	BROADWAY near ALFRED ST.	M.W.R.A.	REGULATOR	2
PC32	SOMERVILLE	SOMERVILLE LIBRARY	WALNUT @ HIGHLAND AVE.	M.W.R.A.	PRESSURE GAUGE	2
PC33	WAKEFIELD	PRESSURE REDUCING VALVE	BROADWAY @ DOYLE	WAKEFIELD P.W.	PRESS. CONTROL	1
PC34	WAKEFIELD	PRESSURE REDUCING VALVE	PROSPECT ST. @ ELM ST.	WAKEFIELD P.W.	PRESS. CONTROL	1
PC35	WALTHAM	LEXINGTON ST. PRESSURE GAUGE	LEXINGTON ST. @ MAIN ST.	M.W.R.A.	PRESSURE GAUGE	1
PC36	WATERTOWN	PLEASANT ST. REGULATOR	PLEASANT ST. near PARAMOUNT PL.	M.W.R.A.	REGULATOR	3
PC37	WATERTOWN	PRESSURE GAUGE	MT.AUBURN @ IRVING ST.	M.W.R.A.	PRESSURE GAUGE	3
PC38	WINCHESTER	PRESSURE REDUCING VALVE	HIGH ST.	WINCHESTER P.W.	PRESS. CONTROL	1
PC39	WINCHESTER	WEST HIGH	JOHNSON RD.	WINCHESTER P.W.	PRESS. CONTROL	1
PC40	WINCHESTER	WEST HIGH	WILDWOOD ST.	WINCHESTER P.W.	PRESS. CONTROL	1

TABLE 3.7f

WATER AND SEWERAGE UTILITIES

TREATMENT PLANTS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	CAPACITY	BACKUP POWER	YEAR BUILT	SEISMIC HAZARD
TP 1	CAMBRIDGE	TREATMENT PLANT	FRESH POND	CAMBRIDGE WATER	WATER		24MGD		1922	3
TP 2	LYNN	LYNN REGIONAL W.T.P.	LYNNWAY & LYNN HAR.	LYNN W.& S.COMM	WASTEWATER	PRIMARY TREATMENT	25.8MGD			2
TP 3	LYNN	LYNN TREATMENT PLANT	near L-SERVICE RES.	LYNN W.& S.COMM	WATER		23MG	YES		1
TP 4	SALEM	H2O POLLUTION PLANT	FORT AVE.	S.E.S.D.	WATER					1
TP 5	SWAMPSCOTT	WASTEWATER TREATMENT	SMITH LANE	SWAMPSCOTT S.D.	WATER					1
TP 6	WINCHESTER	NORTH TREATMENT CTR.	NORTH BORDER RD.	WINCHESTER P.W.	WATER		930000GPD	NO		1
TP 7	WINCHESTER	SOUTH TREATMENT ST.	SOUTH RESERVOIR	WINCHESTER P.W.	WATER		970000GPD	YES		1
TP 8	BEDFORD		HARTWELL RD.	BEDFORD P.W.	WATER					3
TP 9	QUINCY	NUT ISLAND SEWERAGE	TAFTS AVE.	M.S.D.	WASTEWATER		~225MGD			3
TP10	WINTHROP	DEER ISLAND SEWERAGE	ISLAND AVE.	M.S.D.	WASTEWATER		~225MGD			2

TABLE 3.7g

WATER AND SEWERAGE UTILITIES

SEWERAGE METERING STATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	SEISMIC HAZARD
MS 1	SWAMPSCOTT	1.KINGS BEACH TERR.	KINGS BEACH TERRACE	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 2	SWAMPSCOTT	2.BURRILL ST.	BURRILL @ BOYNTON	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 3	SWAMPSCOTT	3.NORTH AVE.	NORTH AVE.	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 4	SWAMPSCOTT	4.HUMPHREY ST.	HUMPHREY ST.	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 5	SWAMPSCOTT	5.HUMPHREY ST.	HUMPHREY near MILLET	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 6	SWAMPSCOTT	6.PRISCILLA RD.	PRISCILLA RD.	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 7	SWAMPSCOTT	7.ATLANTIC AVE.	ATLANTIC @ N.STONE	SWAMPSCOTT S.D.	METERING STATION, SEWER	1
MS 8	DEDHAM		SHERMAN @ PENN CTRL	DEDHAM P.W.	METERING STATION, SEWER	3
MS 9	DEDHAM		COLWELL @ BONHAM RD.	DEDHAM P.W.	METERING STATION, SEWER	2
MS10	DEDHAM		EAST ST. @ HAMILTON	DEDHAM P.W.	METERING STATION, SEWER	2
MS11	DEDHAM		WALNUT @ FAIRBANKS	DEDHAM P.W.	METERING STATION, SEWER	1
MS12	DEDHAM		PARADISE @ VETERANS	DEDHAM P.W.	METERING STATION, SEWER	1
MS13	DEDHAM		EMMETT AVE @ MILLAND	DEDHAM P.W.	METERING STATION,SEWER (2)	1
MS14	DEDHAM		MAVERICK @ COLBURN	DEDHAM P.W.	METERING STATION,SEWER (2)	1
MS15	DEDHAM		WM. @ HIGH @ HARVARD	DEDHAM P.W.	METERING STATION, SEWER	1
MS16	DEDHAM		BINGHAM near EASTERN	DEDHAM P.W.	METERING STATION, SEWER	1
MS17	DEDHAM		COURT near WSHGTN.	DEDHAM P.W.	METERING STATION, SEWER	3
MS18	DEDHAM		BRIDGE ST. @ ZOAR RD	DEDHAM P.W.	METERING STATION, SEWER	1
MS19	DEDHAM		BRIDGE @ CMMNWLTH.	DEDHAM P.W.	METERING STATION, SEWER	1
MS20	DEDHAM		JENNY LANE	DEDHAM P.W.	METERING STATION, SEWER	3
MS21	DEDHAM		RIVERSIDE DR. @ ROCK	DEDHAM P.W.	METERING STATION, SEWER	1

TABLE 3.7h

WATER AND SEWERAGE UTILITIES

SEWERAGE INTERCEPORS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
I 1	LYNN	EASTERN INTERCEPTOR	BROAD @ SANDERSON ST.	LYNN W.& S.COMM	INTERCEPTOR		1885	1
I 2	LYNN	WESTERN INTERCEPTOR	LIGHT @ COTTAGE ST.	LYNN W.& S.COMM	INTERCEPTOR			2
I 3	NAHANT	LOWLANDS INTERCEPTOR	FLASH RD. - POINT RD.	LYNN W.& S.COMM	INTERCEPTOR	12-18"		3
I 4	SALEM	PEABODY-SALEM (NEW)	CENTRAL @ HARDY-FORT AVE.	S.E.S.D.	INTERCEPTOR			1
I 5	SALEM	PEABODY-SALEM (OLD)	CENTRAL @ HARDY-FORT AVE.	S.E.S.D.	INTERCEPTOR			1
I 6	WINCHESTER	MEDFORD-WOBURN	B&M R.R.	M.W.R.A.	INTERCEPTOR	42" REIN. CONCRETE		3
I 7	WINCHESTER	MEDFORD-WOBURN	B&M R.R.	M.W.R.A.	INTERCEPTOR	48" BRICK		1
I 8	WINCHESTER	WOBURN-WINCHESTER	HORN POND BROOK	M.W.R.A.	INTERCEPTOR	15" REIN. CONCRETE		2
I 9	WINCHESTER	WOBURN-WINCHESTER	HORN POND BROOK	M.W.R.A.	INTERCEPTOR	15" REIN. CONCRETE		2
I10	WINCHESTER	WOBURN-WINCHESTER	CROSS ST.	M.W.R.A.	INTERCEPTOR	30" REIN. CONCRETE		2
I11	WOBURN	LEXINGTON RD.	LEXINGTON @ GRACE RD.	M.W.R.A.	INTERCEPTOR	16-24"REIN.CONCRETE		1
I12	WOBURN	READING-WOBURN	COMMONWEALTH AVE.	M.W.R.A.	INTERCEPTOR			1
I13	WOBURN	WILMINGTON-WINCHESTER	B&M R.R. @ WASHINGTON ST.	M.W.R.A.	INTERCEPTOR	15-48"REIN. CONCRETE		3
I14	WOBURN	BURLINGTON-WINCHESTER	BRANDT DR. @ LAKE TERRACE	WOBURN PUB.WKS.	INTERCEPTOR	30-48"REIN. CONCRETE		1
I15	BOSTON	BOSTON MAIN INTERCEPTOR	MASSACHUSETTS AVE.	B.W.S.C.	INTERCEPTOR			3
I16	BOSTON	DORCESTER INTERCEPTOR	NEPONSET AVE.	B.W.S.C.	INTERCEPTOR			3
I17	BOSTON	EAST SIDE INTERCEPTOR	ATLANTIC AVE.	B.W.S.C.	INTERCEPTOR			3
I18	BOSTON	SO.BOSTON INTERCEPTOR(NB)	A ST.	B.W.S.C.	INTERCEPTOR			3
I19	BOSTON	SO.BOSTON INTERCEPTOR(SB)	MARINE RD.	B.W.S.C.	INTERCEPTOR			3
I20	BOSTON	STONY BROOK INTERCEPTOR	TREMONT ST.	B.W.S.C.	INTERCEPTOR			3
I21	BOSTON	WEST SIDE INTERCEPTOR	BEACON ST.	B.W.S.C.	INTERCEPTOR			3

TABLE 3.7i

WATER AND SEWERAGE UTILITIES

SEWERAGE OUTFALLS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF FACILITY	FACILITY CLASSIFICATION	YEAR BUILT	SEISMIC HAZARD
0 1	LYNN	LYNN REGIONAL W.T.P.	3MI. OFFSHORE	LYNN W.& S.COMM	OUTFALL	60" DIAMETER PIPE		1
0 2	LYNN	OUTFALL SEWER	LYNN HARBOR	LYNN W.& S.COMM	OUTFALL	15200' CAST IRON PIPE	1925	3
0 3	MARBLEHEAD	SARGENT RD.	SARGENT RD. @ OCEAN	S.E.S.D.	OUTFALL			1
0 4	SALEM	JUNIPER AVE. OUTFALL	JUNIPER AVE.	S.E.S.D.	OUTFALL	FORCE MAIN		1
0 5	SWAMPSCOTT	TOWN WAY	TOWN WAY	SWAMPSCOTT S.D.	OUTFALL	18" DIAMETER PIPE	1903	1
0 6	SWAMPSCOTT	TOWN WAY	TOWN WAY	SWAMPSCOTT S.D.	OUTFALL	20" DIAMETER PIPE	1940	1
0 7	QUINCY		NUT ISLAND	MWRA	OUTFALL	60" X 6,000'		3
0 8	QUINCY		NUT ISLAND	MWRA	OUTFALL	60" X 6,000'		3
0 9	QUINCY		NUT ISLAND	MWRA	OUTFALL	60" X 1,400'		3
010	QUINCY		NUT ISLAND	MWRA	OUTFALL	60" X 480'		3
011	QUINCY		NUT ISLAND	MWRA	S.OUTFALL	12" X 4.2ml		3
012	WINTHROP		DEER ISLAND	MWRA	OUTFALL			3
013	WINTHROP		DEER ISLAND	MWRA	OUTFALL			3

KEY MWRA = MASSACHUSETTS WATER RESOURCES AUTHOTITY

S.OUTFALL = SLUDGE OUTFALL

TABLE 3.7j
WATER AND SEWERAGE UTILITIES: WATER SYSTEM
REPLACEMENT VALUES ($-THOUSANDS OR TOTAL MILES)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9	1-2	1-2,5	1-3	1-4	3	3-4,6-9	4-6	4-9	5	6-9	7-9
MAIN PIPELINES	20	1 2 3	8.1mi 12.7mi 35.3mi											
DISTRIBUTION PIPELINES	20	1 2 3		33.8mi 5.6mi 12.6mi				26.9mi 7.8mi 14.1mi		19.3mi 13.1mi 8.1mi				21.0mi 3.6mi 19.3mi
WATER PUMPING STATIONS (44 FACILITIES)	26	1 2 3		2,700 1,350 450				2,700 3,600 4,500			3,150 450 900			
WATER AQUADUCTS	14	1 2 3	8,130 11,088 1,480											
WATER TUNNELS	19	1 2 3	55,440 50,265 45,090											
WATER RESERVOIRS	21	1 2 3				1,600 600 400					1,800 400 200			
WATER STORAGE FACILITIES	15(50%) ------ 16(50%)	1 2 3			3,198 . .				2,785 1,070 1,005					
WATER PRESSURE CONTROLS	26	1 2 3					100 10 10					50 50 70	10 10 90	
WATER TREATMENT PLANTS	26	1 2 3	4,200 - 3,800											

TABLE 3.7k
WATER AND SEWERAGE UTILITIES: SEWERAGE SYSTEM
RAPLACEMENT VALUES ($-THOUSANDS OR TOTAL MILES)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9	1	2	3	4	4-9	5	6	7	8	9
SEWERAGE TUNNELS	19	1	89,327										
		2	-										
		3	-										
SEWERAGE INTERCEPTORS/ DISTRIBUTION LINES	20	1		18.4mi	2.2mi	32.2mi	10.4mi		0.2mi	-	2.8mi	10.4mi	10.7mi
		2		9.1mi	2.7mi	14.8mi	2.2mi		3.6mi	2.7mi	0.9mi	1.5mi	1.7mi
		3		19.3mi	3.0mi	31.5mi	8.2mi		24.5mi	8.8mi	25.6mi	5.0mi	18.0mi
SEWERAGE PUMPING STATION (101 FACILITIES)	26	1		8,075	4,250	8,075		1,700					
		2		850	425	3,400		850					
		3		3,825	-	6,800		4,675					
SEWERAGE METERING STATIONS	26	1	75										
		2	10										
		3	20										
SEWERAGE TREATMENT PLANTS	26	1	-										
		2	-										
		3	60,000										
SEWERAGE OUTFALLS	20	1	3.8mi										
		2	-										
		3	11.2mi										

3.8 Electric Power Utility

3.8.1 Overview. The study area is served by the Belmont Electric Light Department, the Boston Edison Company, the Cambridge Electric Light Company, the Massachusetts Electric Company, the Marblehead Municipal Light Department, and the Wakefield Municipal Light Department.

The majority of the power requirements of the study area are provided by five generating facilities located within it. The exceptions are the requirements for peaking power during times of extreme summer temperature or times of disaster such as hurricanes. These generating facilities are located in Boston, Cambridge, Everett, Marblehead, and Salem; detailed information about them is listed in Table 3.8a.

The generating stations are connected by high-voltage transmission lines, operating at 345-kV and 115-kV, to the main substations, which serve as the hubs for the high-voltage network. The main substations also serve to transform the power from the high-voltage network to the lower-voltage 23-kV distributor network through transformers located in the main substations. The 23-kV distribution network is used to distribute the power to the distribution and service substations located near the consumers. Table 3.8b lists the main, distribution, and service substations located in the study area.

3.5.2 Engineering Classifications and Replacement Values. In establishing replacement values for power generating stations and substations, the values of both equipment and buildings were considered. The engineering structure classifications used are for electrical equipment and substations, however, because these represent the primary value and earthquake vulnerability of the facilities.

The engineering structure classifications and replacements values for the electric power utility facilities are listed in Table 3.8c. The

values shown for main transmission lines include towers. The distribution lines (23-kV or less) were ignored in determining the total replacement cost because it is believed they will sustain negligible damage from the postulated earthquake.

TABLE 3.8a

ELECTRIC POWER UTILITY

POWER GENERATING FACILITIES

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	CLASSIFICATION	CAPACITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	SEISMIC HAZARD
G 1	CAMBRIDGE	BLACKSTONE GENER.ST.	45 BLACKSTONE ST.	CAMBRIDGE ELEC.	BRICK,STEEL 6 STORY	23Mw	MASONRY	MED.	3
G 2	CAMBRIDGE	KENDALL GENERATING	265 FIRST ST.	CAMBRIDGE ELEC.	BRICK,BLOCK,STEEL	65Mw	MASONRY		3
G 3	CAMBRIDGE	JET DIESELS	265 FIRST ST.	CAMBRIDGE ELEC.	GENERATING STATION	42Mw			3
G 4	MARBLEHEAD	COMMERCIAL ST.	80 COMMERCIAL ST.	MARBLEHEAD ELEC	GENERATING & DISTRIB	1Mw			3
G 5	MARBLEHEAD	DIESEL	80 COMMERCIAL ST.	MARBLEHEAD ELEC	GENERATING STATION	5Mw			3
G 6	BOSTON	NEW BOSTON, #400	L ST.	BOSTON EDISON	GENERATING STATION	760Mw			3
G 7	BOSTON	L ST., #4	L ST.	BOSTON EDISON	GENERATING STATION	22Mw			3
G 8	EVERETT	MYSTIC 200	MYSTIC	BOSTON EDISON	GENERATING STATION	415Mw			3
G 9	EVERETT	MYSTIC 250	MYSTIC VIEW	BOSTON EDISON	GENERATING STATION	670Mw			3
G10	SALEM	SALEM NO. 1	SALEM HARBOR	MASS. ELECTRIC	GENERATING STATION	83Mw			3
G11	SALEM	SALEM NO. 2	SALEM HARBOR	MASS. ELECTRIC	GENERATING STATION	80Mw			3
G12	SALEM	SALEM NO. 3	SALEM HARBOR	MASS. ELECTRIC	GENERATING STATION	152Mw			3
G13	SALEM	SALEM NO. 4	SALEM HARBOR	MASS. ELECTRIC	GENERATING STATION	446Mw			3

TABLE 3.8b

ELECTRIC POWER UTILITY

MAJOR SUBSTATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF SERVICE	CLASSIFICATION	BUILDING VALUE	YEAR BUILT	SEISMIC HAZARD
E 1	BELMONT	PRINCE ST. STATION	PRINCE ST.	BELMONT ELEC.	SERVICE	CEMENT BLOCK			2
E 2	BELMONT	STATION 3	UNDERWOOD @ HITTINGE	BELMONT ELEC.	DISTRIB	BRICK, SUBSTATION		1969	3
E 3	BELMONT	SUBSTATION 2	OAKLEY RD.	BELMONT ELEC.	SERVICE	BRICK, 1 STORY		1969	2
E 4	BELMONT	UNIT A SUBST.	NEAR CONCORD AVE.	BELMONT ELEC.	DISTRIB	MAIN SUBST.			3
E 5	CAMBRIDGE	ABERDEEN DISTRIB.ST.	60R ABERDEEN	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLO.CONCRETE			3
E 6	CAMBRIDGE	ALEWIFE BULK SWITCH	60 WHEELER ST.	CAMBRIDGE ELEC.	SERVICE	CONCRETE BLOCK,STEEL	750000	1981	3
E 7	CAMBRIDGE	AMORY ST.DISTRIB.CTR	AMORY ST.	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLO.CONCRETE		1964	3
E 8	CAMBRIDGE	BLACKSTONE SWITCHING	45 BLACKSTONE ST.	CAMBRIDGE ELEC.	SERVICE	BRICK,CONCRETE 3STOR	1200000	1925	3
E 9	CAMBRIDGE	CAMBRIDGE DISTRIB.ST	10 ROBERTS ST.	CAMBRIDGE ELEC.	SERVICE	BRICK,STEEL 20'	30000		3
E 10	CAMBRIDGE	CHARLES ST.SWITCHING	12 CHARLES ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 11	CAMBRIDGE	CONCORD ST.SWITCHING	495 CONCORD ST.	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLOSED 10'			3
E 12	CAMBRIDGE	EDMUNDS SWITCHING ST	7 EDMUNDS ST.	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLO.CONCRETE			3
E 13	CAMBRIDGE	HAMPSHIRE SWITCHING	26 HAMPSHIRE ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE SLAB			3
E 14	CAMBRIDGE	HARVARD SUBSTATION	HOLYOKE PLACE	CAMBRIDGE ELEC.	SERVICE	SUBSTATION			3
E 15	CAMBRIDGE	HEALEY ST.NOISE RED.	21 HEALEY ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,WOOD 20'	40000	1940	3
E 16	CAMBRIDGE	HOLYOKE SUBSTATION	HOLYOKE PLACE	CAMBRIDGE ELEC.	SERVICE	SUBSTATION			3
E 17	CAMBRIDGE	KENDALL JETS STATION	265 FIRST ST.	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLO.ELEC.PRO		1960	3
E 18	CAMBRIDGE	MELLEN ST.SWITCHING	8R MELLEN ST.	CAMBRIDGE ELEC.	SERVICE	BRICK,STEEL	35000		3
E 19	CAMBRIDGE	OTIS ST.SWITCHING	201 OTIS ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 20	CAMBRIDGE	PACIFIC ST.SWITCHING	24 PACIFIC ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 21	CAMBRIDGE	POTTER ST.SWITCHING	POTTER ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 22	CAMBRIDGE	PROSPECT BULK SWITCH	255 PROSPECT ST.	CAMBRIDGE ELEC.	SERVICE	CONCRETE BLOCK,STEEL	600000	1964	3
E 23	CAMBRIDGE	PUTNAM ST.SWITCHING	227 PUTNAM AVE	CAMBRIDGE ELEC.	SERVICE	STEEL ENCLO.CONCRETE			3
E 24	CAMBRIDGE	S-BUSS KENDALL SWITC	265 FIRST ST.	CAMBRIDGE ELEC.	SERVICE	CONCRETE BLOCK,STEEL	350000	1979	3
E 25	CAMBRIDGE	SHERMAN ST.SWITCHING	114 SHERMAN ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 26	CAMBRIDGE	SMITH PL.SWITCHING	SMITH PLACE	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 27	CAMBRIDGE	VASSAR ST.SWITCHING	315 VASSAR ST.	CAMBRIDGE ELEC.	SERVICE	STEEL,CONCRETE 10'			3
E 28	CAMBRIDGE	WALDEN ST.SWITCHING	52 WALDEN ST.	CAMBRIDGE ELEC.	SERVICE	WOOD,STEEL 20'	45000		3
E 29	EVERETT	GLENDALE #6	695 BROADWAY	MASS.ELECTRIC	DISTRIB	3 STORY, SUBSTATION		1900	2
E 30	EVERETT	NORMAN #8	70 NORMAN ST.	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG		1910	3

TABLE 3.8b (cont.)
ELECTRIC POWER UTILITY
MAJOR SUBSTATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF SERVICE	CLASSIFICATION	BUILDING VALUE	YEAR BUILT	SEISMIC HAZARD
E 31	EVERETT	THORNDIKE #10	37 THORNDIKE ST.	MASS.ELECTRIC	DISTRIB	2 STORY SUBSTATION		1900	2
E 32	LYNN	BRIDGE #6	BRIDGE ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	2
E 33	LYNN	FAYETTE #3	FAYETTE ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	1
E 34	LYNN	GRANITE #12	GRANITE ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1940	1
E 35	LYNN	HUDSON #7	HUDSON TERACE	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	2
E 36	LYNN	LYNNWAY #21	436 LYNNWAY	MASS.ELECTRIC	MAIN	2,3 & 1,2 STORY BLDG		1880	3
E 37	LYNN	QUINN #24	QUINN RD.	MASS.ELECTRIC	DISTRIB	SM.METAL SUBSTATION		1950	1
E 38	LYNN	WESTERN #4	WESTERN AVE.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	1
E 39	EVERETT	EVERETT #37	REAR,170 MEDFORD ST.	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1960	3
E 40	MALDEN	MALDEN #5	55 CENTER ST.	MASS.ELECTRIC	DISTRIB	4 STORY SUBSTATION		1920	3
E 41	MALDEN	MAPLEWOOD #16	235 BROADWAY	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1950	3
E 42	MARBLEHEAD	CLIFTON SUB.	AMES RD.	MARBLEHEAD ELEC	DISTRIB	SUBSTATION			1
E 43	MARBLEHEAD	VILLAGE SUBSTATION	GRIDLER RD.	MARBLEHEAD ELEC	DISTRIB	SUBTRANSMISSION			3
E 44	MARBLEHEAD	WILKINS ST. SUB.	WOODFIN TERRACE	MARBLEHEAD ELEC	SERVICE	SUBSTATION			2
E 45	MEDFORD	CODDING #64	CODDING AVE.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1930	3
E 46	MEDFORD	LAMBERT #91	48 LAMBERT ST.	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG.		1930	3
E 47	MEDFORD	MEDFORD #9	56 SALEM ST.	MASS.ELECTRIC	DISTRIB	2 STORY SUBSTATION		1900	3
E 48	MEDFORD	WELLINGTON #11	37 WOODRUF AVE.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1930	3
E 49	MEDFORD	WEST MEDFORD #17	7 PLAYSTEAD RD.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1930	3
E 50	MELROSE	MELROSE #2	204 HOWARD ST.	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1900	1
E 51	MELROSE	MELROSE #25	204 HOWARD ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1900	1
E 52	MELROSE	MELROSE #3	HEYWOOD AVE.	MASS.ELECTRIC		CABLE TERMINAL			1
E 53	MELROSE	MELROSE #4	5 UPHAM ST.	MASS.ELECTRIC	DISTRIB	4 STORY SUBSTATION		1910	2
E 54	MELROSE	PINE BANKS #67	STONE AVE.	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG.		1950	3
E 55	NAHANT	NAHANT #79	WARD ST. & CASTLE WY	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	3
E 56	QUINCY	FIELD ST. SUBSTATION	FIELD @ MORRISON	MASS.ELECTRIC	MAIN	2 STORY BRICK BLDG.		1920	3
E 57	QUINCY	HOUGH'S NECK SUB.	SEA ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.			3
E 58	QUINCY	ATLANTIC SUB.	SAGAMORE ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.			3
E 59	QUINCY	EAST WEYMOUTH	COMMERCIAL @ WHARF	MASS. ELECTRIC	MAIN	SUBSTATION, NO BLDG.			3
E 60	QUINCY	NORTH QUINCY	SPRUCE oppo. OAK	MASS. ELECTRIC	MAIN	PRECAST CONCRETE		1970	3

TABLE 3.8b (cont.)
ELECTRIC POWER UTILITY
MAJOR SUBSTATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF SERVICE	CLASSIFICATION	BUILDING VALUE	YEAR BUILT	SEISMIC HAZARD
E 61	QUINCY	STATE ST.SUBSTATION	NEWPORT AVE.@ HERITG	MASS.ELECTRIC	MAIN	SUBSTATION			3
E 62	QUINCY	WEST QUINCY SUB.	CROSS @ COPELAND	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG.			1
E 63	QUINCY	WOLLASTON SUB.	WILLETT @ FERNDALE	MASS.ELECTRIC	SERVICE	2 STORY BRICK BLDG.		1930	3
E 64	REVERE	REVERE #35	CALUMET ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1910	3
E 65	REVERE	REVERE #7	21 RAILROAD AVE.	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1940	3
E 66	SALEM	PEABODY #1	PEABODY ST.	MASS.ELECTRIC	SERVICE	SUBSTATION			3
E 67	SALEM	BOSTON ST. #3	BOSTON ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1910	3
E 68	SALEM	CANAL ST.	CANAL ST.	MASS.ELECTRIC		115KV CABLE TERMINAL		1950	1
E 69	SALEM	HIGHLAND AVE.#2A	HIGHLAND AVE.	MASS.ELECTRIC		CABLE TERMINATION		1910	3
E 70	SALEM	NORTH RIVER	OFF BRIDGE ST.	MARBLEHEAD ELEC		115KV CABLE TERMINAL		1950	3
E 71	SALEM	SALEM #2	VALLEY ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1910	1
E 72	SALEM	SALEM HARBOR #15	24 FORT AVE.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1920	3
E 73	SALEM	WEST SALEM #29	MUSSOLINI RD.	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1940	1
E 74	SAUGUS	GOLDEN HILLS #90	REAR,117 HOWARD ST.	MASS.ELECTRIC	MAIN	1 STORY SUBSTATION		1970	1
E 75	SAUGUS	KENT #13	KENT ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1940	1
E 76	SAUGUS	DENVER #23	DENVER ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1950	1
E 77	SAUGUS	VINE #8	VINE ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	3
E 78	SAUGUS	WALNUT #11	WALNUT ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	1
E 79	SWAMPSCOTT	BURRILL #2	BURRILL ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1920	1
E 80	SWAMPSCOTT	DANVERS #69	DANVERS RD.	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG.		1940	1
E 81	SWAMPSCOTT	HUMPHREY #1	HUMPHREY ST.	MASS.ELECTRIC	SERVICE	1 STORY SUBSTATION		1930	1
E 82	SWAMPSCOTT	PARADISE #22	PARADISE RD.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1930	1
E 83	SWAMPSCOTT	TEDESCO #9	HUMPHREY ST.	MASS.ELECTRIC	SERVICE	SUBSTATION, NO BLDG.		1950	2
E 84	WINTHROP	METCALF SQUARE #96	262 WINTHROP ST.	MASS.ELECTRIC	DISTRIB	SUBSTATION, NO BLDG.		1980	2
E 85	WINTHROP	ARGYLE #22	20 ARGYLE ST.	MASS.ELECTRIC	DISTRIB	1 STORY SUBSTATION		1910	3
E 86	BOSTON	#110	BAKER ST.	BOSTON EDISON	MAIN	SUBSTATION			1
E 87	BOSTON	#2	HAWKINS ST.	BOSTON EDISON	MAIN	SUBSTATION			2
E 88	BOSTON	#3	ATLANTIC AVE.	BOSTON EDISON	MAIN	SUBSTATION			2
E 89	BOSTON	#385	K ST.	BOSTON EDISON	MAIN	SUBSTATION			3
E 90	BOSTON	#483	DEWAR ST.	BOSTON EDISON	MAIN	SUBSTATION			3

TABLE 3.8b (cont.)
ELECTRIC POWER UTILITY
MAJOR SUBSTATIONS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	TYPE OF SERVICE	CLASSIFICATION	BUILDING VALUE	YEAR BUILT	SEISMIC HAZARD
E 91	BOSTON	#492	SCOTIA ST.	BOSTON EDISON	MAIN	SUBSTATION			3
E 92	BOSTON	#514	KINGSTON ST.	BOSTON EDISON	MAIN	SUBSTATION			3
E 93	BOSTON	#71	CARVER ST.	BOSTON EDISON	MAIN	SUBSTATION			3
E 94	BOSTON	BRIGHTON, #329	CAMBRIDGE @ BRIGHTON	BOSTON EDISON	MAIN	SUBSTATION			2
E 95	BOSTON	HYDE PARK, #496	HYDE PARK AVE.	BOSTON EDISON	MAIN	SUBSTATION			1
E 96	CAMBRIDGE	NORTH CAMBRIDGE,#509	HARVEY ST.	BOSTON EDISON	MAIN	SUBSTATION			3
E 97	CHELSEA	#488	SPRUCE @ EVERETT	BOSTON EDISON	MAIN	SUBSTATION			3
E 98	EVERETT	EVERETT #412	MONSANTO CHEMICAL CO	BOSTON EDISON	DISTRIB	SUBSTATION			3
E 99	LEXINGTON	#533	SPRINGDALE RD.	BOSTON EDISON	MAIN	SUBSTATION			1
E100	LEXINGTON	LEXINGTON RING, #320	oppo. MASS. AVE.	BOSTON EDISON	MAIN	SUBSTATION			2
E101	NEWTON	NEWTON HIGHLANDS,292	ATHELSTANE RD.	BOSTON EDISON	MAIN	SUBSTATION			2
E102	SOMERVILLE	#402	PROSPECT HILL AVE.	BOSTON EDISON	MAIN	SUBSTATION			2
E103	WALTHAM	#450	TRAPELO RD.	BOSTON EDISON	MAIN	SUBSTATION			1
E104	WALTHAM	WALTHAM RING, #282	EDGE HILL RD., ext.	BOSTON EDISON	MAIN	SUBSTATION			1
E105	WATERTOWN	#467	HARRIETTE AVE.	BOSTON EDISON	MAIN	SUBSTATION			1
E106	WOBURN	NORTH WOBURN, #375	DRAGON CT.	BOSTON EDISON	MAIN	SUBSTATION			1
E107	WOBURN	WOBURN RING, #211	near COUNTRY CLUB LN	BOSTON EDISON	MAIN	SUBSTATION			1

TABLE 3.8c
ELECTRIC POWER UTILITIES
REPLACEMENT VALUES ($-THOUSANDS OR TOTAL MILES)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	ZONES \ CELLS	1-9	1	3-4	5-6	7,8,9
GENERATING STATIONS	3	1	-				
		2	-				
		3	1,077,885				
MAJOR TRANSMISSION LINES	18	1	31.7mi				
		2	7.9mi				
		3	53.9mi				
MAJOR SUBSTATIONS	22	1	18,000				
		2	3,600				
		3	2,400				
DISTRIBUTION SUBSTATIONS	22	1		3,600	1,800	-	900
		2		1,200	1,500	1,800	600
		3		2,400	3,900	5,100	7,800

3.9 Communications

3.9.1 Overview. Communications includes telephone, radio, and television service in the study area.

Telephone System: The Boston study area is provided telephone service by the New England Telephone Company through a network of central offices. Information regarding the location of central office buildings and details regarding main trunk lines is considered privileged and confidential by New England Telephone. Therefore, none of this information is detailed in the inventory. A representative listing of telephone central offices, without addresses, is given in Table 3.9a.

Radio: The study area is provided AM and FM public and private radio service by approximately 40 stations. These stations have transmitting antennas that range from under 100 feet in height to over 1,100 feet. Most of the radio stations are located in the central Boston area, some in large buildings and others in private facilities. Most of the transmitting antennas are on high buildings and in the outskirts of the greater Boston area. Almost all of the major radio stations have emergency backup power at both their broadcasting studios and their transmission towers. Transmitting towers located away from the densely populated areas have emergency generators, while those towers located atop tall buildings do not. Many stations rent space on the same transmitting tower. These radio stations and their antennas are detailed in Tables 3.9b and 3.9c. All radio stations are required by the FCC to make Emergency Broadcast Service (EBS) announcements.

Television: Seven public and private television stations were identified in the study area. The transmitting antennas range in height from 800 feet to 1,200 feet and are located both in the central Boston area on high buildings and on the outskirts of the Boston

area. The majority of the broadcasting studios are located in the downtown area of Boston. Of all the studios, only two have transmitting towers within the study area. All other transmission towers lie outside the study area in Needham and Needham Heights. The television stations, studios, and antennas are detailed in Tables 3.9d and 3.9e, respectively. All television stations are required by the FCC to make EBS announcements. The majority of stations in the area have backup power.

Cable Television: Cable television service is provided to the study area by approximately 18 cable service corporations with offices and service areas located throughout the greater Boston area. The majority of the corporations are situated outside the central Boston area in the surrounding towns and villages; most of these are located within the communities which they serve. They are detailed in Table 3.9f. Most of the cable television stations have backup power.

3.9.2 Engineering Classifications and Replacement Values. Engineering structure classifications for all central telephone offices were provided by the New England Telephone Company, and the radio, television, and cable television station engineering classifications were established through sampling. Table 3.9g is a list of the engineering structure classifications for all of the communication facilities. The replacement values for all communication facilities include the value of equipment. Replacement values for telephone offices are detailed by engineering structure classification, cells, and seismic hazard zones in Table 3.9h.

Replacement values for all radio and television stations and towers were lumped together by engineering structure classification, cells, and seismic hazard zones, as detailed in Table 3.9i. The replacement values assumed for stations located in steel high-rise structures were for the studios themselves and not for the whole building.

TABLE 3.9a

COMMUNICATIONS

TELEPHONE OFFICES

CODE	OPERATOR OF FACILITY	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCUTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
T 1	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T 2	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T 3	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T 4	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	STEEL	MED	PRE	3
T 5	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T 6	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	HIGH	PRE	3
T 7	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	2
T 8	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	MED.	PRE	1
T 9	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	MED.	PRE	2
T10	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	HIGH	PRE	3
T11	NEW ENGLAND TELEPHONE	OFFICE, MICROWAVE TW	REIN. CONC.	HIGH	PRE	3
T12	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	HIGH	PRE	1
T13	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	MED	PRE	1
T14	NEW ENGLAND TELEPHONE	CENTRAL OFFICES	REIN. CONC.	LOW	PRE	2
T15	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T16	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	2
T17	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T18	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	STEEL	HIGH	POST	3
T19	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	HIGH	PRE	3
T20	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T21	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T22	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	2
T23	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	HIGH	PRE	2
T24	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	MED.	PRE	3
T25	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T26	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T27	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T28	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	MED.	PRE	3
T29	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T30	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3

TABLE 3.9a (cont.)
COMMUNICATIONS
TELEPHONE OFFICES

CODE	OPERATOR OF FACILITY	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCUTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
T31	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T32	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	2
T33	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	3
T34	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	PRE	1
T35	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	POST	2
T36	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	POST	2
T37	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	POST	2
T38	NEW ENGLAND TELEPHONE	CENTRAL OFFICE	REIN. CONC.	LOW	POST	2

KEY

YEAR BUILT PRE = BUILT PRIOR TO 1977
POST = BUILT AFTER 1977

TABLE 3.9b
COMMUNICATIONS
RADIO STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	OPERATOR OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
R 1	BOSTON	WBCN	1265 BOYLSTON ST.	FM	HEMISPHERE BROADCASTING CORP.				YES	3
R 2	BOSTON	WBOS	441 STUART ST.	FM	CHANNEL BROADCSTING INC.					3
R 3	BOSTON	WBUR	630 COMMONWEALTH AVE.	FM	THE TRUSTEES OF BOSTON UNIV.				YES	3
R 4	BOSTON	WBZ	1170 SOLDIERS FIELD RD.	AM	WESTINGHOUSE BROADCASTING INC.				YES	3
R 5	BOSTON	WEEI	4450 PRUDENTIAL TOWER	AM	HELEN BROADCASTING CO. INC.				YES	3
R 6	BOSTON	WERS	126 BEACON ST.	FM	EMERSON COLLEGE				YES	3
R 7	BOSTON	WGBH	125 WESTERN AVE.	FM	WGBH EDUCATIONAL FOUNDATION	REIN. CONC.	LOW		YES	3
R 8	BOSTON	WHDH	441 STUART ST.	AM	SCONNIX BROADCASTING					3
R 9	BOSTON	WILD	90 WARREN ST.	AM	NASH COMMUNICATIONS CORP.				NO	1
R10	BOSTON	WJIB	68 COMMERCIAL WHARF	FM	NBC SUBSIDIARY INC.	REIN. CONC.			ON AIR ONLY	3
R11	BOSTON	WMEX	330 STUART ST.	AM	GREATER BOSTON RADIO	REIN. CONC.	HIGH	1920	YES	3
R12	BOSTON	WMJX	330 STUART ST.	FM	Co-OWNED WITH WMEX(AM)	REIN. CONC.	HIGH	1920	YES	3
R13	BOSTON	WODS	30 WINTER ST.	FM	CBS INC.				YES	3
R14	BOSTON	WRBB	360 HUNTINGTON AVE.	FM	NORTHEASTERN UNIVERSITY					3
R15	BOSTON	WRKO	3 FENWAY PLAZA	AM	RKO GENERAL INC.	REIN. CONC.	MED.	1940	YES	3
R16	BOSTON	WROR	3 FENWAY PLAZA	FM	Co-OWNED WITH WRKO(AM)	REIN. CONC.	MED.	1940	YES	3
R17	BOSTON	WROL	312 STUART ST.	AM	PILGRIM BROADCASTING CO.				NO	3
R18	BOSTON	WUMB	U. MASS. BOSTON, HARBOR CAMPUS	FM	U. OF MASS.					3
R19	BOSTON	WUNR	160 N. WASHINGTON ST.	AM	CHAMPION BROADCASTING SYSTEM INC.				NO	3
R20	BOSTON	WZLX	200 CLARENDON ST.	FM	FIRST MEDIA CORP.	STEEL (J.H. Tower)	HIGH	1964	YES	3
R21	BOSTON	WZOU	313 CONGRESS ST.	FM	ARDMAN BROADCASTING CORP.					3
R22	CAMBRIDGE	WHRB	45 QUINCY ST.	FM	HARVARD RADIO BROADCASTING CO. INC.				NO	3
R23	CAMBRIDGE	WLVG	1972 MASSACHUSETTS AVE.	AM	J. CHRISTOPHER ROBINSON, TRUST					3
R24	CAMBRIDGE	WMBR	3 AMES ST.	FM	TECHNOLOGY BROADCASTING CORP.	REIN. CONC.	LOW	1910	NO	3
R25	LYNN	WFNX	25 EXCHANGE ST.	FM	MCC BROADCASTING INC.				NO	2
R26	LYNN	WLYN	25 EXCHANGE ST.	AM	PURITAN BROADCAST SERVICE INC.					2
R27	MEDFORD	WMFO	BOX 65, TUFTS COLLEGE	FM	TRUSTEES OF TUFTS COLLEGE				NO	1
R28	MEDFORD	WXKS	99 REVERE BEACH PARKWAY	AM	KISS LIMITED PARTNERSHIP				YES	3
R29	MEDFORD	WXKS	99 REVERE BEACH PARKWAY	FM	KISS LIMITED PARTNERSHIP				STUDIO ONLY	3
R30	MILTON	WEZE	BOX 26, 100 RIVERSIDE AVE.	AM	NEW ENGLAND CONTINENTAL MEDIA INC.					2

TABLE 3.9b (cont.)

COMMUNICATIONS

RADIO STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	OPERATOR OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
R31	MILTON	WMLN	1071 BLUE HILL AVE.	FM	CURRY COLLEGE				NO	2
R32	NEWTON	WNTN	143 RUMFORD AVE.	AM	NEWTON BROADCASTING CORP.				NO	2
R33	NEWTON	WZBC	McELROY 105, BOSTON COLLEGE	FM	TRUSTEES OF BOSTON COLLEGE					2
R34	QUINCY	WJDA	29 BRACKETT	AM	SOUTH SHORE BROADCASTING CO.					3
R35	SALEM	WESX	BOX 710	AM	NORTH SHORE BROADCASTING CORP.	WOOD	LOW	1938	NO	2
R36	SALEM	WMWM	352 LAFAYETTE ST.	FM	SALEM STATE COLLEGE					1
R37	WALTHAM	WBRS	BRANDEIS UNIVERSITY	FM	BRANDEIS UNIVERSITY					1
R38	WALTHAM	WCRB	750 SOUTH ST.	FM	CHARLES RIVER BROADCASTING CO.				YES	3
R39	WALTHAM	WOLW	473 WINTER ST.	AM	ACTON CORP.				NO	1
R40	WINCHESTER	WHSR	80 SKILLINGS RD.	FM	WINCHESTER SCHOOL DEPT.					3
R41	WOBURN	WSSH	500 WEST CUMMINGS PARKWAY	AM	NOBLE BROADCAST OF BALLYBUNION INC.	REIN. CONC.	MED.		YES	2
R42	WOBURN	WSSH	500 WEST CUMMINGS PARKWAY	FM	NOBLE BROADCAST OF BALLYBUNION INC.	REIN. CONC.	MED.		YES	2

TABLE 3.9c
COMMUNICATIONS
RADIO STATION ANTENNAS

CODE	CITY	FACILITY NAME	ANTENNA HEIGHT (FEET)	ATTENNA LOCATION	BROADCAST FREQUENCY	KILOWATTS	SEISMIC HAZARD
R/A 1	BOSTON	WBCN	740	PRUDENTIAL TOWER, BOSTON (R-PT-A)	104.1mhz	19kw	3
R/A 2	BOSTON	WBOS	800		92.9mhz	50kw	
R/A 3	BOSTON	WBUR	1046	750 SAWMILL BROOK PKWY, NEWTON	90.9mhz	7.2kw	1
R/A 4	BOSTON	WBZ		OUT OF STUDY AREA	1030khz	50kw	
R/A 5	BOSTON	WEEI	360	480 MYSTIC VALLEY PRKY, MEDFORD	590khz	5kw-U	3
R/A 6	BOSTON	WERS	727	PRUDENTIAL TOWER, BOSTON (R-PT-A)	88.9mhz	3kw	3
R/A 7	BOSTON	WGBH	650	OUT OF STUDY AREA	89.7mhz	100kw	
R/A 8	BOSTON	WHDH			850khz	50kw-U	
R/A 9	BOSTON	WILD	255	CORPORATION WAY, MEDFORD	1090khz	5kw-U	3
R/A10	BOSTON	WJIB	1010	OUT OF STUDY AREA	96.9mhz	8.7kw	
R/A11	BOSTON	WMEX		75 CONCORD AVE, LEXINGTON	1150khz	5kw-U	3
R/A12	BOSTON	WMJX	750	PRUDENTIAL TOWER, BOSTON (R-PT-A)	106.7mhz	25kw	3
R/A13	BOSTON	WODS	938	CHESTNUT ST, NEWTON	103.3mhz	16.5kw	1
R/A14	BOSTON	WRBB	178		104.9mhz	18.5kw	
R/A15	BOSTON	WRKO	400	OUT OF STUDY AREA	680khz	50kw-U	
R/A16	BOSTON	WROR	1190	CHESTNUT ST, NEWTON	98.5mhz	8.1kw	1
R/A17	BOSTON	WROL	280	SALEM TURNPIKE, SAUGUS	950khz	5kw-D	3
R/A18	BOSTON	WUMB	205		91.9mhz	1kw	
R/A19	BOSTON	WUNR	350	750 SAWMILL BROOK PRWY, NEWTON	1600khz	5kw-U	1
R/A20	BOSTON	WZLX	500	PRUDENTIAL TOWER, BOSTON (R-PT-A)	100.7mhz	50kw	3
R/A21	BOSTON	WZOU	1140		94.5mhz	5kw	
R/A22	CAMBRIDGE	WHRB	110	75 MT. AUBURN, CAMBRIDGE	95.3mhz	3kw	3
R/A23	CAMBRIDGE	WLVG			740khz	250w-D	
R/A24	CAMBRIDGE	WMBR	285	60 WADSWORTH, CAMBRIDGE	88.1mhz	200w	3
R/A25	LYNN	WFNX	170	12 MURRAY ST, MEDFORD	101.7mhz	3kw	3
R/A26	LYNN	WLYN			1360khz	1kw-D	
R/A27	MEDFORD	WMFO	75	LOCATED AT STUDIO	91.5mhz	125kw	1
R/A28	MEDFORD	WXKS	199	LOCATED AT STUDIO (2 TOWERS)	1430khz	5kw-D	3
R/A29	MEDFORD	WXKS	720	PRUDENTIAL TOWER, BOSTON (R-PT-A)	107.9mhz	21kw	3
R/A30	MILTON	WEZE			1260khz	5kw-U	

TABLE 3.9c (cont.)
COMMUNICATIONS
RADIO STATION ANTENNAS

CODE	CITY	FACILITY NAME	ANTENNA HEIGHT (FEET)	ATTENNA LOCATION	BROADCAST FREQUENCY	KILOWATTS	SEISMIC HAZARD
R/A31	MILTON	WMLN	98	LOCATED AT STUDIO	91.5mhz	170w	2
R/A32	NEWTON	WNTN	200	LOCATED AT STUDIO	1550khz	10kw-D	2
R/A33	NEWTON	WZBC	220		90.3mhz	1kw	
R/A34	QUINCY	WJDA		SEA & PALMER ST.	1300khz	1kw-D	3
R/A35	SALEM	WESX	187	LOCATED AT STUDIO	1230khz	1kw-D	2
R/A36	SALEM	WMWM	73		91.7mhz	400w	
R/A37	WALTHAM	WBRS	67		91.7mhz	35w	
R/A38	WALTHAM	WCRB	918	OUT OF STUDY AREA	102.5mhz	15kw	
R/A39	WALTHAM	WOLW	300	750 SOUTH ST, WALTHAM	1330khz	5kw-U	3
R/A40	WINCHESTER	WHSR	60		91.9mhz	10w	
R/A41	WOBURN	WSSH	400	411 WAVERLY OAKS RD, WALTHAM (4)	1510khz	50kw-U	1
R/A42	WOBURN	WSSH		OUT OF STUDY AREA	99.5mhz	32kw	

TABLE 3.9d
COMMUNICATIONS
TV STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	OPERATOR OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	BACK UP POWER	SEISMIC HAZARD
TV1	BOSTON	WBZ-TV	1170 SOLDIERS FIELD RD.	TV	GROUP W TELEVISION INC.	MASONRY	LOW	NO	3
TV2	BOSTON	WLVI-TV	75 MORRISSEY BLVD.	TV	GANNETT MASSACHUSETTS BCSTG.	MASONRY	LOW	YES	3
TV3	BOSTON	WNEV-TV	7 BULFINCH PLACE, GOVT. CTR.	TV	NEW ENGLAND TELEVISION CORP			YES	2
TV4	BOSTON	WQTV	1660 SOLDIERS FIELD RD.	TV	MONITOR TELEVISION INC.	STEEL	LOW	NO	3
TV5	BOSTON	WSBK-TV	83 LEO BIRMINGHAM PKWY	TV	SCI TELEVISION INC.	REIN. CONC.	LOW	YES	3
TV6	BOSTON	WGBH-TV	125 WESTERN AVE.	TV	WGBH EDUCATIONAL FOUNDATION	MASONRY	LOW	YES	3
TV7	BOSTON	WGBX-TV	125 WESTERN AVE.	TV	WGBX-TV	MASONRY	LOW	YES	3

TABLE 3.9e
COMMUNICATIONS
TV STATION ANTENNAS

CODE	CITY	FACILITY NAME	ANTENNA HEIGHT (FEET)	ATTENNA LOCATION	BROADCAST FREQUENCY	KILOWATTS	SEISMIC HAZARD
TV/A1	BOSTON	WBZ-TV	1160'	OUT OF STUDY AREA	66-72MHz	60.3kw	
TV/A2	BOSTON	WLVI-TV	1186	OUT OF STUDY AREA	722-728MHz	2240kW	
TV/A3	BOSTON	WNEV-TV	1000,	TOWER ROAD, NEWTON	174-180MHz	316kw	1
TV/A4	BOSTON	WQTV	785'	PRUDENTIAL CENTER	794-800MHz	1337kw	3
TV/A5	BOSTON	WSBK-TV	1180'	OUT OF STUDY AREA	614-620MHz	3160kw	
TV/A6	BOSTON	WGBH-TV	1040'	OUT OF STUDY AREA	54-60MHz	87.1kw	
TV/A7	BOSTON	WGBX-TV	1080'	OUT OF STUDY AREA	650-656MHz	1510kw	

TABLE 3.9f

COMMUNICATIONS

CABLE TV STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	BACK UP POWER	YEAR LISENCED	SEISMIC HAZARD
CTV 1	ARLINGTON	ARLINGTON CABLESYSTEMS CORP.	81 MYSTIC ST.	CABLE TV				6/81	3
CTV 2	BOSTON	CABLEVISION SYSTEMS BOSTON CORP.	28 TRAVIS ST.	CABLE TV				12/82	3
CTV 3	BROOKLINE	CABLEVISION OF BROOKLINE	139 AMORY ST.	CABLE TV				1/84	3
CTV 4	CAMBRIDGE	AMERICAN CABLESYSTEMS OF CAMBRIDGE	88 SHERMAN ST.	CABLE TV				4/86	3
CTV 5	DEDHAM	AMERICAN CABLESYSTEMS OF DEDHAM	902 PROVIDENCE HWY.	CABLE TV	MASONRY	LOW	YES	3/83	3
CTV 6	LEXINGTON	ADAMS-RUSSEL CABLEVISION LEXINGTON	1403 MASS. AVE.	CABLE TV				6/82	2
CTV 7	LYNN	WARNER AMEX CABLE COMMUNICATIONS INC.	26 TREMONT	CABLE TV			NO	9/80	2
CTV 8	MARBLEHEAD	CONTINENTAL CABLEVISION INC.	217 PLEASANT	CABLE TV				11/85	3
CTV 9	MEDFORD	WARNER AMEX CABLE COMMUNICATIONS INC.	282 MYSTIC AVE.	CABLE TV				1/72	3
CTV10	QUINCY	QUINCY CABLESYSTEMS CORP.	81 SCHOOL ST.	CABLE TV				1/82	3
CTV11	REVERE	COLONIAL CABLEVISION OF REVERE INC.	41 MARBLE ST.	CABLE TV				12/71	3
CTV12	SAUGUS	CONTINENTAL CABLEVISION INC.	55 JACKSON ST.	CABLE TV				7/81	1
CTV13	WAKEFIELD	WARNER AMEX CABLE COMMUNICATIONS INC.	27 WATER ST.	CABLE TV			NO	3/83	2
CTV14	WALTHAM	WALTHAM TELE COMMUNICATIONS	BOX 9000	CABLE TV				2/86	3
CTV15	WATERTOWN	CONTINENTAL CABLEVISION OF MASS. INC.	116 MAIN ST.	CABLE TV				6/82	1
CTV16	WOBURN	GREATER BOSTON CABLE CORPS.	25 WALTHAM	CABLE TV				2/70	3

TABLE 3.9g
COMMUNICATIONS
ENGINEERING STRUCTURE CLASSIFICATION

FACILITY	# SAMPLED / TOTAL #	ENGINEERING STRUCTURE CLASSIFICATION											
		1	2	3	4	5	6	7	8	9	10	11	12
TELEPHONE OFFICES	38 -- 38						66%	12%	16%			3%	3%
RADIO, TV, & CABLE TV STATIONS	15 -- 65	7%		20%			26%	20%	13%		7%		7%

TABLE 3.9h
COMMUNICATIONS: TELEPHONE OFFICES
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-4	5-9
REIN. CONC. LOW-RISE	6	1	9,500	28,500
		2	9,500	19,010
		3	7,100	30,900
REIN. CONC. MED-RISE	7	1	1,730	2,160
		2	1,730	3,450
		3	1,300	5,610
REIN. CONC. HIGH-RISE	8	1	2,300	2,880
		2	2,300	4,610
		3	1,730	7,480
STEEL LOW-RISE	10	1	430	540
		2	430	870
		3	330	1,400
STEEL MED-RISE	12	1	430	540
		2	430	870
		3	330	1,400

TABLE 3.91
COMMUNICATIONS: RADIO & TELEVISION STATIONS & TOWERS
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-5	6,8,9	7	1,2,3, 4,6,8	5,7,9
TOWERS	18	1				491	-
		2				30	21
		3				48	652
WOOD FRAME LOW-RISE	1	1	200	100	100		
		2	770	200	-		
		3	2,800	160	1,450		
MASONRY LOW-RISE	3	1	600	300	300		
		2	2,200	600	-		
		3	8,000	450	4,150		
REIN. CONC. LOW-RISE	6	1	780	390	390		
		2	2,860	780	-		
		3	10,400	590	5,400		
REIN. CONC. MED-RISE	7	1	600	300	300		
		2	2,200	600	-		
		3	8,000	450	4,150		
REIN. CONC. HIGH-RISE	8	1	400	200	200		
		2	1,430	400	-		
		3	5,200	300	2,700		
STEEL LOW-RISE	10	1	200	100	100		
		2	770	200	-		
		3	2,800	160	1,450		
STEEL HIGH-RISE	12	1	200	100	100		
		2	770	200	-		
		3	2,800	160	1,450		

3.10 Emergency Public Facilities

3.10.1 Overview. Emergency public facilities include police stations, fire stations, Civil Defense emergency operating centers, and National Guard armories.

Police Stations: This category includes only local police stations. County sheriffs and state police are not included in the scope of the study. Of the 41 police stations identified, one-fourth were in Boston. Other than Boston, the distribution is one police station per town in the study area. Most of the stations were constructed between 1900 and 1930 although the Lexington police station was built in the 1850s. Typically the stations are low-rise masonry structures that have been upgraded. Table 3.10a is an inventory of these police stations. All police stations have backup power.

Fire Stations: Like police stations, because of the age of the metropolitan area, most of the five stations are older (prior to 1930) low-rise masonry structures that have been upgraded. Over 130 fire stations were identified, and slightly less than one-third of these are in Boston. Fire stations in 28 of the cities and towns of the study area belong to the Metro Fire Stations Cooperative, an organization created to increase fire fighting ability by pooling resources. Table 3.10b is an inventory of fire stations. All fire stations have backup power.

Civil Defense Emergency Operating Facilities: Every town in the study area has a Director of Civil Defense governed by the Massachusetts Civil Defense Agency, and every town except Marblehead has an emergency operating center. Typically this structure is a town hall, city hall, or the police or fire department. The 30 emergency operating centers are detailed in Table 3.10c. The majority of emergency operating centers have backup power.

National Guard Armories: There is at least one National Guard armory in almost every cell. Boston proper has 2 of the 13 inventoried in Table 3.10d. All of these structures were built after 1900, and their construction is typically low-rise masonry. The buildings generally have classrooms and offices as well as a drill shed for training troops. The armories also have weapons vaults. None of the armories has backup power.

3.10.2 Engineering Classifications and Replacement Values. Engineering structure classifications for police and fire stations, emergency operating centers, and National Guard armories were established through sampling. The number sampled and total number of facilities for each of these types of facilities are indicated in Table 3.10e. Replacement values for all emergency public facilities are detailed by cells and seismic hazard zones in Table 3.10f.

TABLE 3.10a
EMERGENCY PUBLIC FACILITIES
POLICE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
P 1	ARLINGTON		112 MYSTIC	POLICE, LOCAL	REIN. CONC.	LOW	1983	YES	3
P 2	BEDFORD		3 ELM	POLICE, LOCAL					1
P 3	BELMONT		460 CONCORD AVE.	POLICE, LOCAL	MASONRY	LOW	1930's	YES	3
P 4	BOSTON	HEADQUARTERS	154 BERKELEY	POLICE, LOCAL					3
P 5	BOSTON	AREA A	40 NEW SUDBURY	POLICE, LOCAL					3
P 6	BOSTON	EAST BOSTON NGBD. STA.	69 PARIS	POLICE, LOCAL					3
P 7	BOSTON	AREA B	135 DUDLEY	POLICE, LOCAL					3
P 8	BOSTON	MATTAPAN NGBD. STA.	1165 BLUE HILL AVE	POLICE, LOCAL					1
P 9	BOSTON	AREA C	40 GIBSON	POLICE, LOCAL					3
P10	BOSTON	SOUTH BOSTON NGBD. STA.	273 D. ST.	POLICE, LOCAL					3
P11	BOSTON	AREA D	7 WARREN AVE	POLICE, LOCAL					2
P12	BOSTON	BRIGHTON NGBD. STA.	301 WASHINGTON	POLICE, LOCAL					2
P13	BOSTON	AREA E	1708 CENTRE	POLICE, LOCAL					1
P14	BOSTON	HYDE PARK NGBD. STA.	1249 HYDE PARK AVE.	POLICE, LOCAL					1
P15	BROOKLINE		350 WASH.	POLICE, LOCAL					3
P16	CAMBRIDGE		5 WESTERN AVE.	POLICE, LOCAL					3
P17	CHELSEA		17 PARK	POLICE, LOCAL	MASONRY	MED.	1857	YES	3
P18	DEDHAM		600 HIGH	POLICE, LOCAL	MASONRY	LOW	1962	YES	1
P19	EVERETT		45 ELM	POLICE, LOCAL	MASONRY	LOW	1981	YES	2
P20	LEXINGTON		1575 MASS. AVE.	POLICE, LOCAL	MASONRY	LOW	1950's	YES	2
P21	LYNN		SUTTON ST.	POLICE, LOCAL					2
P22	MALDEN		200 PLEASANT	POLICE, LOCAL	MASONRY	LOW	1976	YES	3
P23	MARBLEHEAD		11 GERRY ST.	POLICE, LOCAL	MASONRY	LOW	1960	YES	3
P24	MEDFORD		100 MAIN	POLICE, LOCAL	REIN. CONC.	LOW	1960's	YES	3
P25	MELROSE		56 W. FOSTER	POLICE, LOCAL	MASONRY	LOW	1930's	YES	2
P26	MILTON		40 HIGHLAND	POLICE, LOCAL	WOOD	LOW	1972	YES	1
P27	NAHANT		198 NAHANT RD.	POLICE, LOCAL	WOOD	LOW	1900	YES	1
P28	NEWTON		1321 WASHINGTON	POLICE, LOCAL					2
P29	QUINCY		1 SEA	POLICE, LOCAL	MASONRY	LOW		YES	3
P30	REVERE		23 PLEASANT	POLICE, LOCAL					3

TABLE 3.10a (cont.)
EMERGENCY PUBLIC FACILITIES
POLICE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
P31	SALEM		17 CENTRAL	POLICE, LOCAL					3
P32	SAUGUS		6 TAYLOR	POLICE, LOCAL					3
P33	SOMERVILLE		220 WASHINGTON	POLICE, LOCAL	MASONRY	LOW	1930-40's	YES	3
P34	STONEHAM		47 CENTRAL	POLICE, LOCAL	MASONRY	LOW	1974	YES	1
P35	SWAMPSCOTT		86 BURRILL	POLICE, LOCAL	MASONRY	LOW	1937	YES	1
P36	WAKEFIELD		1 UNION	POLICE, LOCAL					1
P37	WALTHAM		155 LEXINGTON	POLICE, LOCAL	MASONRY	LOW	1962	YES	1
P38	WATERTOWN		34 CROSS	POLICE, LOCAL	REIN. CONC.	LOW	1933	YES	3
P39	WINCHESTER		30 MT. VERNON	POLICE, LOCAL	MASONRY	LOW	1930	YES	3
P40	WINTHROP		1 METCALF SQ.	POLICE, LOCAL	MASONRY	LOW	1920'S	YES	2
P41	WOBURN		10 COMMON	POLICE, LOCAL	MASONRY	LOW	1920'S	YES	1

KEY
AREA A = DOWNTOWN - CHARLESTOWN - EAST BOSTON
AREA B = ROXBURY - MATTAPAN
AREA C = DORCHESTER - SOUTH BOSTON
AREA D = BACK BAY - SOUTHEND - FENWAY - ALLSTON - BRIGHTON
AREA E = WEST ROXBURY - HYDE PARK - JAMAICA PLAIN - ROSLINDALE

TABLE 3.10b
EMERGENCY PUBLIC FACILITIES
FIRE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
FS 1	ARLINGTON	FIRE STATION	112 MYSTIC	FIRE, LOCAL					3
FS 2	ARLINGTON	FIRE STATION	FRANKLIN ST. @ BROADWAY	FIRE, LOCAL					3
FS 3	ARLINGTON	FIRE STATION	MASSACHUSETTS AVE. @ WALNUT ST	FIRE, LOCAL					1
FS 4	ARLINGTON	FIRE STATION	PARK AVE. oppo. PARK CIRCLE	FIRE, LOCAL					1
FS 5	BEDFORD	FIRE STATION	55 THE GREAT RD.	FIRE, LOCAL	MASONRY	LOW	1949	YES	1
FS 6	BELMONT	FIRE STATION	50 LEONARD ST.	FIRE, LOCAL	MASONRY	LOW	1898	YES	3
FS 7	BOSTON	FIRE STATION	123 OLIVER	FIRE, LOCAL					2
FS 8	BOSTON	FIRE STATION	130 CHESTNUT HILL A.	FIRE, LOCAL					1
FS 9	BOSTON	FIRE STATION	174 DUDLEY	FIRE, LOCAL					1
FS 10	BOSTON	FIRE STATION	1870 COLOMBUS AVE.	FIRE, LOCAL					1
FS 11	BOSTON	FIRE STATION	1884 DORCHESTER AVE.	FIRE, LOCAL					1
FS 12	BOSTON	FIRE STATION	1940 CENTRE ST.	FIRE, LOCAL					1
FS 13	BOSTON	FIRE STATION	200 CAMBRIDGE ST.	FIRE, LOCAL					2
FS 14	BOSTON	FIRE STATION	200 COLOMBUS AVE.	FIRE, LOCAL					1
FS 15	BOSTON	FIRE STATION	239 SUMNER ST.	FIRE, LOCAL					3
FS 16	BOSTON	FIRE STATION	272 D ST.	FIRE, LOCAL					3
FS 17	BOSTON	FIRE STATION	301 NEPONSET AVE.	FIRE, LOCAL					3
FS 18	BOSTON	FIRE STATION	34 WINTHROP ST.	FIRE, LOCAL					1
FS 19	BOSTON	FIRE STATION	36 WASHINGTON ST.	FIRE, LOCAL					1
FS 20	BOSTON	FIRE STATION	360 SARATOGA ST.	FIRE, LOCAL					2
FS 21	BOSTON	FIRE STATION	392 HANOVER ST.	FIRE, LOCAL					3
FS 22	BOSTON	FIRE STATION	425 FANEUIL ST.	FIRE, LOCAL					2
FS 23	BOSTON	FIRE STATION	460 CAMBRIDGE ST.	FIRE, LOCAL					2
FS 24	BOSTON	FIRE STATION	5115 WASHINGTON ST.	FIRE, LOCAL					1
FS 25	BOSTON	FIRE STATION	525 MAIN ST.	FIRE, LOCAL					3
FS 26	BOSTON	FIRE STATION	560 HUNTINGTON AVE.	FIRE, LOCAL					3
FS 27	BOSTON	FIRE STATION	60 FAIRMOUNT AVE.	FIRE, LOCAL					1
FS 28	BOSTON	FIRE STATION	618 HARRISON AVE.	FIRE, LOCAL					3
FS 29	BOSTON	FIRE STATION	641 COLOMBIA RD.	FIRE, LOCAL					1
FS 30	BOSTON	FIRE STATION	659 CENTRE ST.	FIRE, LOCAL					1

TABLE 3.10b (cont.)
EMERGENCY PUBLIC FACILITIES
FIRE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
FS 31	BOSTON	FIRE STATION	700 E. FOURTH ST.	FIRE, LOCAL					3
FS 32	BOSTON	FIRE STATION	700 TREMONT	FIRE, LOCAL					3
FS 33	BOSTON	FIRE STATION	9 GALLIVAN BLVD.	FIRE, LOCAL					1
FS 34	BOSTON	FIRE STATION	941 BOYLSTON ST.	FIRE, LOCAL					3
FS 35	BOSTON	FIRE STATION	945 CANTERBURY ST.	FIRE, LOCAL					1
FS 36	BOSTON	FIRE STATION	975 BLUE HILL AVE.	FIRE, LOCAL					1
FS 37	BOSTON	FIRE STATION	PARISH ST.	FIRE, LOCAL					1
FS 38	BOSTON	FIRE STATION	ASHLEY ST. @ BLACKINTON ST.	FIRE, LOCAL					2
FS 39	BOSTON	FIRE STATION	CALLENDER ST. @ LYFORD ST.	FIRE, LOCAL					1
FS 40	BOSTON	FIRE STATION	CAMBRIDGE ST. @ HARVARD	FIRE, LOCAL					3
FS 41	BOSTON	FIRE STATION	CENTRE ST. @ HIGHLAND	FIRE, LOCAL					1
FS 42	BOSTON	FIRE STATION	MT.VERNON ST. oppo. RIVER ST.	FIRE, LOCAL					3
FS 43	BOSTON	FIRE STATION	NEPONSET VY.PKWY. @ HAMILTON	FIRE, LOCAL					2
FS 44	BOSTON	FIRE STATION	O'REILLY WAY @ MONUMENT	FIRE, LOCAL					2
FS 45	BOSTON	FIRE STATION	RIVER ST. near TEMPLE ST.	FIRE, LOCAL					3
FS 46	BOSTON	FIRE STATION	SUMMER ST. @ A ST.	FIRE, LOCAL					3
FS 47	BOSTON	FIRE STATION	W.FOURTH ST. @ DORCHESTER	FIRE, LOCAL					1
FS 48	BOSTON	FIRE STATION	WESTERN AVE. @ WAVERLEY ST.	FIRE, LOCAL					3
FS 49	BOSTON	HEADQUARTERS	115 SOUTHAMPTON ST.	FIRE, LOCAL	MASONRY	LOW	1949	YES	3
FS 50	BOSTON	FIRE & POLICE STATION	FOREST ST. @ PLEASANT AVE.	FIRE,POLICE, LOCAL					1
FS 51	BOSTON	FIRE & POLICE STATION	LOGAN AIRPORT	FIRE,POLICE, LOCAL					3
FS 52	BROOKLINE	FIRE STATION	338 WASHINGTON ST.	FIRE, LOCAL	MASONRY	LOW	1920's	YES	3
FS 53	BROOKLINE	FIRE STATION	BOYLSTON @ HIGH ST.	FIRE, LOCAL					3
FS 54	BROOKLINE	FIRE STATION	BOYLSTON ST. @ RESERVOIR RD.	FIRE, LOCAL					1
FS 55	BROOKLINE	FIRE STATION	WASHINGTON ST. @ FAIRBANKS ST.	FIRE, LOCAL					1
FS 56	CAMBRIDGE	FIRE STATION	491 BROADWAY	FIRE, LOCAL					3
FS 57	CAMBRIDGE	FIRE STATION	CAMBRIDGE ST. @ SCIARAPPA	FIRE, LOCAL					2
FS 58	CAMBRIDGE	FIRE STATION	HAMPSHIRE ST. @ CAMBRIDGE ST.	FIRE, LOCAL					3
FS 59	CAMBRIDGE	FIRE STATION	LEXINGTON AVE. near HURON	FIRE, LOCAL					2
FS 60	CAMBRIDGE	FIRE STATION	MASS AVE oppo. MAIN @ COLUMBIA	FIRE, LOCAL					3

TABLE 3.10b (cont.)
EMERGENCY PUBLIC FACILITIES
FIRE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
FS 61	CAMBRIDGE	FIRE STATION	ORCHARD @ MILLER ST.	FIRE, LOCAL					3
FS 62	CAMBRIDGE	FIRE STATION	PORTLAND @ THORNDIKE ST.	FIRE, LOCAL					3
FS 63	CAMBRIDGE	FIRE STATION	RIVER ST. @ KELLY RD.	FIRE, LOCAL					3
FS 64	CAMBRIDGE	FIRE STATION	WINSLOW @ SHERMAN @ GARDEN	FIRE, LOCAL					2
FS 65	CHELSEA	FIRE STATION	307 CHESTNUT	FIRE, LOCAL	MASONRY	LOW	1908	YES	3
FS 66	CHELSEA	FIRE STATION	BROADWAY betw. WEBSTER & GREEN	FIRE, LOCAL					3
FS 67	CHELSEA	FIRE STATION	CROSS ST. @ PARK ST.	FIRE, LOCAL					3
FS 68	CHELSEA	FIRE STATION	FOURTH ST. @ SPRUCE ST.	FIRE, LOCAL					3
FS 69	CHELSEA	FIRE STATION	SAGAMORE AVE. @ CHEEVER ST.	FIRE, LOCAL					2
FS 70	DEDHAM	FIRE & POLICE STATION	436 WASHINGTON ST.	FIRE,POLICE, LOCAL					1
FS 71	EVERETT	FIRE STATION	384 BROADWAY	FIRE, LOCAL	MASONRY	LOW	1930	YES	2
FS 72	EVERETT	FIRE STATION	FERRY ST near CLARENCE ST.	FIRE, LOCAL					2
FS 73	EVERETT	FIRE STATION	HANCOCK ST. oppo. GILMORE	FIRE, LOCAL					2
FS 74	LEXINGTON	FIRE STATION	45 BEDFORD ST.	FIRE, LOCAL	MASONRY	LOW	1950's	YES	2
FS 75	LYNN	FIRE STATION	725 WESTERN	FIRE, LOCAL					2
FS 76	LYNN	FIRE STATION	ACORN @ HOLLINGSWORTH	FIRE, LOCAL					1
FS 77	LYNN	FIRE STATION	BOX PL. @ BROAD ST.	FIRE, LOCAL					2
FS 78	LYNN	FIRE STATION	BROADWAY near PENDEXTER	FIRE, LOCAL					1
FS 79	LYNN	FIRE STATION	FRANKLIN ST. @ BAKER	FIRE, LOCAL					2
FS 80	LYNN	FIRE STATION	LAW SQ. @ ESSEX ST.	FIRE, LOCAL					1
FS 81	LYNN	FIRE STATION	MERRILL ST. @ LEWIS	FIRE, LOCAL					1
FS 82	LYNN	FIRE STATION	NEPTUNE @ COMMERCIAL	FIRE, LOCAL					2
FS 83	LYNN	FIRE STATION	POND @ CHESTNUT	FIRE, LOCAL					3
FS 84	LYNN	FIRE STATION	TUSCAN RD. @ LYNNFIELD ST.	FIRE, LOCAL					1
FS 85	LYNN	FIRE STATION	WOODLAWN @ PINE RD.	FIRE, LOCAL					1
FS 86	LYNN	FIRE STATION	oppo. HARVEST @ EASTERN	FIRE, LOCAL					1
FS 87	LYNN	FIRE STATION	oppo. TOWER AVE. @ BOSTON	FIRE, LOCAL					2
FS 88	MALDEN	FIRE STATION	1 SPRAGUE ST.	FIRE, LOCAL	MASONRY	LOW	1930's	YES	3
FS 89	MALDEN	FIRE STATION	OLIVER ST. @ CLAPP ST.	FIRE, LOCAL					3
FS 90	MARBLEHEAD	FIRE STATION	1 OCEAN AVE.	FIRE, LOCAL					

TABLE 3.10b (cont.)
EMERGENCY PUBLIC FACILITIES
FIRE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
FS 91	MEDFORD	FIRE STATION	120 MAIN ST.	FIRE, LOCAL	MASONRY	LOW	1960	YES	3
FS 92	MEDFORD	FIRE STATION	RIVERSIDE AVE. @ B&M R.R.	FIRE, LOCAL					3
FS 93	MEDFORD	FIRE STATION	SALEM ST. @ COURT ST.	FIRE, LOCAL					3
FS 94	MELROSE	CENTRAL FIRE STATION	1 MAIN ST.	FIRE, LOCAL					2
FS 95	MELROSE	FIRE STATION	B&M R.R. near MELROSE ST.	FIRE, LOCAL					2
FS 96	MILTON	FIRE STATION	CANTON AVE.	FIRE, LOCAL	MASONRY	LOW	1880's	YES	1
FS 97	NAHANT	FIRE STATION	FLASH RD.	FIRE, LOCAL					3
FS 98	NEWTON	FIRE STATION	1164 CENTRE ST.	FIRE, LOCAL	MASONRY	LOW	1920's	YES	2
FS 99	NEWTON	FIRE STATION	CHURCH @ RICHARDSON	FIRE, LOCAL					2
FS100	NEWTON	FIRE STATION	ELLIOT @ CIRCUIT ST.	FIRE, LOCAL					1
FS101	NEWTON	FIRE STATION	WATERTOWN ST. @ CRAFTS ST.	FIRE, LOCAL					2
FS102	QUINCY	FIRE STATION	26 QUINCY AVE.	FIRE, LOCAL	MASONRY	LOW	1930's	YES	3
FS103	QUINCY	FIRE STATION	MILLER @ CENTRE ST.	FIRE, LOCAL					1
FS104	REVERE	FIRE STATION	400 BROADWAY	FIRE, LOCAL	MASONRY	LOW	1880's	YES	3
FS105	REVERE	FIRE STATION	REVERE ST. @ FREEMAN	FIRE, LOCAL					3
FS106	SALEM	FIRE DEPT. HDQTRS.	48 LAFAYETTE	FIRE, LOCAL					3
FS107	SALEM	FIRE HOUSE	FORT AVE. near BLOCKHOUSE SQ.	FIRE, LOCAL					3
FS108	SALEM	FIRE STATION	BOSTON @ ESSEX @ HIGHLAND	FIRE, LOCAL					3
FS109	SALEM	FIRE STATION	CHURCH near WASHINGTON	FIRE, LOCAL					3
FS110	SALEM	FIRE STATION	RAYMOND RD. @ LORING AVE.	FIRE, LOCAL					3
FS111	SALEM	FIRE STATION	oppo. NORTH ST. @ MEAD CT.	FIRE, LOCAL					3
FS112	SAUGUS	FIRE STATION	TAYLOR ST. @ FOSTER ST.	FIRE, LOCAL					3
FS113	SOMERVILLE	CENTRAL FIRE STATION	MEDFORD ST. @ McGRATH HWY.	FIRE, LOCAL					2
FS114	SOMERVILLE	FIRE STATION	266 BROADWAY	FIRE, LOCAL					3
FS115	SOMERVILLE	FIRE STATION	HIGHLAND AVE. oppo. CONWELL ST	FIRE, LOCAL					2
FS116	SOMERVILLE	FIRE STATION	LOWELL @ SOMERVILLE AVE.	FIRE, LOCAL					2
FS117	SOMERVILLE	FIRE STATION	SOMERVILLE AVE. @ PROSPECT ST.	FIRE, LOCAL					3
FS118	STONEHAM	FIRE STATION	BLOCK @ CENTRAL ST.	FIRE, LOCAL	MASONRY	LOW	1916	YES	1
FS119	SWAMPSCOTT	CENTRAL FIRE STATION	NEW OCEAN ST. near PINE	FIRE, LOCAL					1
FS120	SWAMPSCOTT	FIRE HOUSE	PURITAN @ HUMPHREY	FIRE, LOCAL					1

TABLE 3.10b (cont.)
EMERGENCY PUBLIC FACILITIES
FIRE STATIONS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
FS121	SWAMPSCOTT	FIRE & POLICE STATION	80 BURRILL ST.	FIRE,POLICE LOCAL					1
FS122	WAKEFIELD	FIRE STATION	37 CRESCENT ST.	FIRE, LOCAL	MASONRY	LOW	1901	YES	1
FS123	WAKEFIELD	FIRE STATION	OAK @ FRANCIS AVE.	FIRE, LOCAL					1
FS124	WALTHAM	FIRE STATION	MOODY ST. @ CHERRY	FIRE, LOCAL					2
FS125	WALTHAM	FIRE STATION	PROSPECT ST. @ VERNON ST.	FIRE, LOCAL					1
FS126	WALTHAM	FIRE & POLICE STATION	175 LEXINGTON ST.	FIRE,POLICE, LOCAL	MASONRY	LOW	1960's	YES	1
FS127	WATERTOWN	FIRE STATION	34 CROSS	FIRE, LOCAL	REIN. CONC.	LOW	1930's	YES	3
FS128	WATERTOWN	FIRE STATION	MT. AUBURN ST. @ MELENDY AVE.	FIRE, LOCAL	REIN. CONC.	LOW	1930's	YES	2
FS129	WATERTOWN	FIRE STATION	ORCHARD ST. @ LOOMIS AVE.	FIRE, LOCAL					1
FS130	WINCHESTER	FIRE & POLICE STATION	WINCHESTER PL. @ MT.VERNON ST.	FIRE,POLICE, LOCAL					3
FS131	WINTHROP	FIRE HOUSE	40 PAULINE	FIRE, LOCAL	MASONRY	LOW	1910	YES	2
FS132	WOBURN	FIRE STATION	654 MAIN ST.	FIRE, LOCAL	MASONRY	LOW	1930's	YES	2
FS133	QUINCY	FIRE STATION	BEALE @ ARLINGTON	FIRE, LOCAL					1

TABLE 3.10c

EMERGENCY PUBLIC FACILITIES

EMERGENCY OPERATING CENTERS

CODE	CITY	FACILITY NAME	LOCATION	OPERATOR OF FACILITY	DIRECTOR OF FACILITY	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
EOC 1	ARLINGTON		291 PARK AVE.	DIRECTOR CIVIL DEFENSE	PHILIP F.CANNIFF					1
EOC 2	BEDFORD	FIRE DEPARTMENT	GREAT RD.	DIRECTOR CIVIL DEFENSE	ROBERT C.BLAKE, JR.	MASONRY	LOW	1949	YES	1
EOC 3	BELMONT	TOWN HALL ANNEX	18 MOORE ST.	DIRECTOR CIVIL DEFENSE	EDWARD P.DOHERTY					1
EOC 4	BOSTON		115 SOUTHHAMPTON	DIRECTOR CIVIL DEFENSE	CHIEF PAUL COOK	MASONRY	MED.	1949		3
EOC 5	BROOKLINE	TOWN HALL	333 WASHINGTON ST.	DIRECTOR CIVIL DEFENSE	MICHAEL SELIB					3
EOC 6	CAMBRIDGE	CAMBRIDGE HOSPITAL	1493 CAMBRIDGE ST.	EMERGENCY MANAGEMENT AGENCY	DAVID B. O'CONNOR				YES	3
EOC 7	CHELSEA	CITY HALL	500 BROADWAY	DIRECTOR CIVIL DEFENSE	FRANK HENRY				YES	2
EOC 8	DEDHAM	DEDHAM POLICE STATION	600 HIGH ST.	DIRECTOR CIVIL DEFENSE	COLONEL RALPH B.POPE	MASONRY	LOW	1962	YES	1
EOC 9	EVERETT		FERRY & ELM ST.	DIRECTOR CIVIL DEFENSE	CHIEF DONALD MENINGER					2
EOC10	LEXINGTON	FIRE DEPARTMENT	45 BEDFORD ST.	DIRECTOR CIVIL DEFENSE	JOHN D.BERGERON	MASONRY	LOW	1950's	YES	2
EOC11	LYNN	CITY HALL	CITY HALL SQUARE	DIRECTOR CIVIL DEFENSE	JOHN D.MONACO	MASONRY	LOW	1948		2
EOC12	MALDEN		22 MOUNTAIN AVE.	EMERGENCY MANAGEMENT AGENCY	WILLIAM J.VINING					1
EOC13	MEDFORD	FIRE DEPARTMENT	120 MAIN ST.	DIRECTOR CIVIL DEFENSE	FREDERICK L.MANGONE	MASONRY	LOW	1960	YES	3
EOC14	MELROSE	CITY HALL	MAIN ST.	DIRECTOR CIVIL DEFENSE	SGT.JOHN F.DENLEY					2
EOC15	MILTON	MILTON POLICE STATION	40 HIGHLAND AVE.	DIRECTOR CIVIL DEFENSE	ARTHUR SOUTHALL	WOOD	LOW	1972	YES	1
EOC16	NAHANT	TOWN HALL	334 NAHANT RD.	DIRECTOR CIVIL DEFENSE	LEE FOX					1
EOC17	NEWTON	CITY HALL	COMMONWEALTH AVE.	DIRECTOR CIVIL DEFENSE	JAY I.W.MOSCOW	MASONRY	LOW	1932		2
EOC18	QUINCY	DPW BLDG.BASEMENT	55 SEA ST.	DIRECTOR CIVIL DEFENSE	FRANCIS X.FINN	REIN. CONC.	LOW	1967		3
EOC19	REVERE	CITY HALL	281 BROADWAY	DIRECTOR CIVIL DEFENSE	DANIEL M.FERRARA				NO	3
EOC20	SALEM	FIRE DEPT.HDQTRS.	48 LAFAYETTE ST.	DIRECTOR CIVIL DEFENSE	JOHN S.SMEDILE					3
EOC21	SAUGUS		MAIN ST.	DIRECTOR CIVIL DEFENSE	MICHAEL V.FAVALE					3
EOC22	SOMERVILLE	DPW BLDG.	FRANEY RD.	CIVIL DEFENSE	not appointed					2
EOC23	STONEHAM	TOWN HALL	35 CENTRAL ST.	DIRECTOR CIVIL DEFENSE	BERNIE PASQUIERRELLO				YES	1
EOC24	SWAMPSCOTT		39 ROSS RD.	DIRECTOR CIVIL DEFENSE	RICHARD E.MAITLAND					1
EOC25	WAKEFIELD	LAFAYETTE BLDG.	LAFAYETTE ST.	DIRECTOR CIVIL DEFENSE	WILLIAM P.HURTON					2
EOC26	WALTHAM		27 LEXINGTON ST.	DIRECTOR CIVIL DEFENSE	ANTHONY A.MANGINI					1
EOC27	WATERTOWN	ADMINISTRATIVE BLDG.	149 MAIN ST.	DIRECTOR CIVIL DEFENSE	CHIEF ROBERT O'REILLY				YES	3
EOC28	WINCHESTER		15 HIGH ST.	DIRECTOR CIVIL DEFENSE	ARTHUR A.MONTOURI					1
EOC29	WINTHROP		12 EDWARD ST.	DIRECTOR CIVIL DEFENSE	GEORGE IORIO					2
EOC30	WOBURN	CITY HALL	COMMON ST.	DIRECTOR CIVIL DEFENSE	CHIEF ROBERT DOHERTY					2

TABLE 3.10d

EMERGENCY PUBLIC FACILITIES

NATIONAL GUARD ARMORIES

CODE	CITY	LOCATION	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	BACK UP POWER	SEISMIC HAZARD
NG 1	BOSTON	925 COMMONWEALTH AVE	MASONRY	MED.	1900	NO	3
NG 2	BOSTON	70 VICTORY RD.	MASONRY	LOW	1960'S	NO	3
NG 3	CAMBRIDGE	450 CONCORD AVE	MASONRY	LOW	1960'S	NO	3
NG 4	CHELSA	113 SPENCER	MASONRY	LOW	1958	NO	3
NG 5	LEXINGTON	459 BEDFORD	MASONRY	LOW	1960'S	NO	3
NG 6	LYNN	38 SO. COMMON	MASONRY	LOW	1940'S	NO	2
NG 7	MALDEN	129 MOUNTAIN AVE.	MASONRY	LOW	1940'S	NO	3
NG 8	MELROSE	120 MAIN ST.	MASONRY	LOW	1957	NO	3
NG 9	NEWTON	1137 WASHINGTON ST.	MASONRY	LOW	1920'S	NO	2
NG10	QUINCY	1000 HANCOCK	MASONRY	LOW	1940'S	NO	3
NG11	SOMERVILLE	191 HIGHLAND	MASONRY	LOW	1940'S	NO	2
NG12	WALTHAM	36 SHARON	MASONRY	LOW	1954	NO	1
NG13	WOBURN	206 MAIN ST.	MASONRY	LOW	1940'S	NO	1

TABLE 3.10e
EMERGENCY PUBLIC FACILITIES
ENGINEERING STRUCTURE CLASSIFICATION

FACILITY	# SAMPLED / TOTAL #	ENGINEERING STRUCTURE CLASSIFICATION											
		1	2	3	4	5	6	7	8	9	10	11	12
POLICE STATIONS	21 / 41	10%		71%	5%		14%						
FIRE STATIONS	20 / 133			90%			10%						
EMERGENCY OPERATING CENTERS	9 / 30	11%		67%	11%		11%						
NATIONAL GUARD	13 / 13			92%	8%								

TABLE 3.10f
EMERGENCY PUBLIC FACILITIES
REPLACEMENT VALUES ($-THOUSANDS)
BY CELLS AND ZONES

FACILITY	CELLS / ZONES	1-9	1	1-3	1-2,5	2-3	3-4,6-9	4-6	4,6	5	7	7-9	8	9
POLICE STATIONS	1			5,682				1,894				3,788		
	2			2,841				4,735				-		
	3			3,788				8,523				7,576		
FIRE STATIONS	1		3,760			1,504			4,136	-	2,632		376	4,888
	2		1,880			1,504			3,384	4,136	1,504		-	-
	3		3,384			752			2,256	6,016	6,768		-	1,128
EMERGENCY OPERATING CENTERS	1				380		665							
	2				665		285							
	3				380		475							
NATIONAL GUARD	1	932												
	2	1,398												
	3	3,728												

3.11 Residential Buildings

3.11.1 Overview. The largest number of housing units in the metropolitan Boston area are found in Boston itself Five other towns stand out with large numbers of units. They are Cambridge, Quincy, Lynn, Somerville, and Newton. Residential buildings in the study area include five basic types of housing structures common to the greater Boston area: single-family dwellings, two-family dwellings, row houses, triple deckers, and apartments.

Row houses and triple deckers are two housing types that are somewhat unique to the study area. Row houses are primarily found in central Boston, with a large group in the Back Bay area adjacent to downtown Boston. Row houses are constructed of a series of single-family dwellings set side by side and sharing common walls. These homes are typically three to four stories with a single front entrance to the street. Most of the row houses were built from 1870 to 1930, and their construction is basically wood floors and roofs with masonry bearing walls. Although originally built as single-family homes, many of the row houses have since been converted to multiple-family dwellings.

Also found in central Boston and Cambridge are the triple deckers. Dorchester has a large number of triple deckers as well. Building laws in effect between 1910 and 1925 contributed to the proliferation of this type of structure. After 1925, changes in the building laws ended their construction. The triple decker is a long, narrow, three-story structure with a thin front and deep extent. The structure usually has some type of porch in the front and a balcony or porch in the back. Triple deckers are of wood frame construction, often involving heavy timber framing. Many of these structures originally housed extended family units with different generations occupying different floors.

Fewer masonry structures exist in the outlying cells of the study area. As the distance from the downtown area increases, housing structures in the suburbs increase in similarity to those of many other American cities; the number of wood frame single-family dwellings becomes increasingly extensive.

Age of construction is very important for assessing probable earthquake damage. Wood frame residences built before about 1940 commonly lacked anchor bolts connecting the wood framing to the foundation. Thus, pre-1940 wood frame buildings are more susceptible to earthquake damage than those constructed after about 1940. Construction of heavy-timber-brick bearing wall buildings, which are also very vulnerable to earthquakes, was discontinued prior to 1940. Table 3.11a shows the number of year-round housing units in the study area constructed before 1940, the number that existed in 1980, and the percentage constructed before 1940. Table 3.11a shows that about 60% of the residential buildings in the entire study area were constructed before 1940.

3.11.2 Engineering Classifications and Replacement Values. As illustrated in Table 3.1b, residential buildings make up a large portion of the value of facilities in the study area. Accordingly, it is important that these facilities be carefully evaluated.

Critical information for making an evaluation of the effects of the postulated earthquake for the study area are the engineering classifications (structural system and height) and replacement value (cost of present replacement) of facilities. Census data provided by the U.S. Government provide a wealth of information pertaining to residential buildings. For a town or city, available census data give, for example: the median value of living units, the total number of year-round housing units, the number of persons per living unit, and story heights categorized as 1-3 stories, 4-6 stories, or 7 or more stories. Census data do not provide information on either structural

systems or construction materials, however. Census data also do not provide information directly related to the building heights that correspond to the criteria of this study. Another shortcoming of the census data is that the median values for owner-occupied residences are given, but similar data for renter-occupied housing units are not given. This is not to say, however, that census data are not useful for this type of study.

A second important resource for establishing an inventory of residential buildings is data published by the Massachusetts Department of Revenue (DOR). Since the passage of Proposition 2-1/2 in Massachusetts, DOR has regularly published values for residential, commercial, industrial, and personal property that are specified as being the fair market values. In addition, in 1980, DOR published these data for each town or city in Massachusetts, which also includes the following residential property distinctions: one-unit (R1), two-unit (R2), three-unit (R3), four-unit (R4), condominium (CO), and apartment (A). While the 1980 values are low, they provide useful information for distinguishing replacement values for various heights of buildings.

For this study, the engineering classifications established for buildings are based on height and construction material. Low-rise buildings are 1 to 3 stories, medium-rise buildings are 4 to 8 stories, high-rise buildings are 9 to 19 stories, and tall buildings are 20 or more stories. Note that tall buildings are treated separately in Section 3.13 of this report. Construction material distinctions made in this study for buildings include: wood frame, masonry, reinforced concrete, and steel. The required inventory information consists of replacement values for these various building heights and construction materials.

Information regarding the construction materials of residential buildings is not available from published data. This information can

be obtained in a variety of ways, such as street sampling or reviews of building permit data. However, because of the vast number and great variety of residential units in the study area, this was deemed impractical. Specifically, Table 3.11b shows that there are about 700,000 residential units in the study area. This implies that there are several hundred thousand residential buildings in the study area, and random sampling would require reviewing a minimum of 10,000 to 20,000 residential buildings. After substantial review of this matter, it was concluded that a practical means for identifying the construction materials of residential buildings in the study area was to divide the area in to natural zones, and to utilize expert opinion for identifying construction materials for residential buildings.

In this regard, the study area was divided into nineteen natural zones. Each of the natural zones is geographically distinct and has some measure of internal consistency with respect to the building types and densities present. Parts of Winchester and Lexington, for example, have very similar residential construction. The majority of residential construction in Boston is dramatically different, however. A primary objective in preparing the natural zones map was to delineate where wood frame buildings predominated and where masonry buildings predominated. In addition, building heights were identified in the natural zones map as well. Specific information obtained for each of 19 natural zones was the percentage of buildings in each of the following classes:

One Family:	Low-rise wood frame Low-rise masonry
Two Family:	Low-rise wood frame Low-rise masonry
Row Housing:	Low-rise wood frame Low-rise masonry Medium-rise masonry
Triple Decker:	Low-rise wood frame Low-rise masonry

Apartments:	Low-rise wood frame Low-rise masonry Medium-rise wood frame Medium-rise masonry High-rise masonry High-rise reinforced concrete High-rise steel

These data were subsequently integrated into the engineering classifications applicable for study, which include:

Low-rise:	wood frame masonry
Medium-rise:	wood frame masonry
High-rise:	masonry reinforced concrete (RC) steel

The final inventory of residential buildings for the study area was established by integrating five distinct data bases as follows:

1. Census Data (1980): Number of stories vs. number of units
2. Census Data: Housing units category vs. number of units
3. 1980 Massachusetts Department of Revenue Data: R1, R2, R3, R4, CO, RC
4. 1987 Massachusetts Department of Revenue Data: Assessed values of residential properties
5. Natural Zones Data*: Construction material and height

All of the structure inventory and classification criteria established for this study (see Chapter 4) were implemented in estimating

*Professor Daniel L. Schodek of Harvard University initially proposed the concept of integrating natural zones and expert data with census data. The availability of the Massachusetts Department of Revenue data made his proposal both feasible and reliable. Professor Schodek provided the natural zones inventory data.

the percentage of various classes of buildings in each natural zone. It is particularly noteworthy that the masonry classification was used if masonry is the exterior cladding. It is recognized that a majority of the high-rise buildings in the study area are steel frame, but the majority of these buildings have masonry exteriors.

Table 3.11c gives the number of buildings, based on the above-mentioned integration, for each of the engineering classifications and nine geographical cells of this study. Table 3.11d gives residential building values for the various engineering classifications of buildings for seismic hazard zones 1, 2, and 3, respectively.

TABLE 3.11a

YEAR-ROUND HOUSING UNITS: 1980 AND PRE-1940

City	1980 Number of Units	Pre-1940 Number of Units	Pre-1940 Percent of 1980 Number of Units
Arlington	18,874	9,826	52.1
Bedford	3,809	598	15.7
Belmont	9,891	6,400	64.7
Boston	241,343	151,931	63.0
Brookline	24,369	13,208	54.2
Cambridge	41,278	27,955	67.7
Chelsea	10,461	7,402	70.8
Dedham	8,409	3,878	46.1
Everett	14,659	10,824	73.8
Lexington	9,767	2,730	28.0
Lynn	32,617	22,329	68.5
Malden	21,464	13,385	62.4
Marblehead	8,223	4,296	52.2
Medford	20,640	14,397	69.8
Melrose	10,949	6,557	59.9
Milton	8,555	4,935	57.7
Nahant	1,490	790	53.0
Newton	29,090	17,364	59.7
Quincy	34,207	19,034	55.6
Revere	17,105	8,299	48.5
Salem	15,879	10,664	67.2
Saugus	8,298	4,009	48.3
Somerville	30,942	24,118	77.9
Stoneham	7,652	2,818	36.8
Swampscott	5,223	3,119	59.7
Wakefield	8,817	4,282	48.6
Waltham	21,218	2,236	10.5
Watertown	13,560	7,920	58.4
Winchester	6,924	3,300	47.7
Winthrop	7,578	4,929	65.0
Woburn	12,721	4,400	34.6
Total	706,012	417,933	

**Source:* U.S. Census Data, 1980

TABLE 3.11b

NUMBER OF YEAR-ROUND HOUSING UNITS

City	Population* (1980)	Number of Year-Round Housing Units* (1980)
Arlington	48,219	18,874
Bedford	13,067	3,809
Belmont	26,100	9,891
Boston	562,994	241,343
Brookline	55,062	24,369
Cambridge	95,322	41,278
Chelsea	25,431	10,461
Dedham	25,298	8,409
Everett	37,195	14,659
Lexington	29,479	9,767
Lynn	78,471	32,617
Malden	53,386	21,464
Marblehead	20,126	8,223
Medford	58,076	20,640
Melrose	30,055	10,949
Milton	25,860	8,555
Nahant	3,947	1,490
Newton	83,622	29,090
Quincy	84,743	34,207
Revere	42,423	17,105
Salem	38,220	15,879
Saugus	28,476	8,298
Somerville	77,372	30,942
Stoneham	21,424	7,652
Swampscott	13,837	5,223
Wakefield	24,895	8,817
Waltham	58,200	21,218
Watertown	34,384	13,560
Winchester	20,710	6,924
Winthrop	19,294	7,578
Woburn	36,626	12,721
Total	1,771,314	706,012

**Source*: U.S. Census Data, 1980

TABLE 3.11c
NUMBER OF RESIDENTIAL BUILDINGS

FACILITY	ENGR. STRUCTURE CLASS	CELLS												
		1-9	1-3	4-6	7-9	1	2	3	4	5	6	7	8	9
LOW-RISE WOOD FRAME	1					34,270	25,240	19,040	32,890	46,530	21,830	25,840	25,830	68,100
LOW-RISE MASONRY	3					3,050	2,670	2,520	5,620	7,910	5,150	11,010	4,050	4,750
MID-RISE WOOD FRAME	2		40	50	40									
MID-RISE MASONRY	4					120	50	25	135	200	220	410	230	450
MID-RISE REIN. CONC.	6		20	20	40									
HIGH-RISE MASONRY	5		30	40	60									
HIGH-RISE REIN. CONC.	8	20												
HIGH-RISE STEEL	12	15												

TABLE 3.11d
REPLACEMENT VALUES ($-MILLIONS)
FOR
RESIDENTIAL BUILDINGS

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-9	1-3	4-6	7-9	1	2	3	4	5	6	7	8	9
LOW-RISE WOOD FRAME	1	1					2,240.9	2,390.9	1,854.2	3,112.2	843.7	948.0	224.7	1,830.0	5,232.0
		2					1,273.2	605.1	794.7	561.2	49.6	1,200.8	224.7	1,558.0	1,464.9
		3					1,578.8	709.7	1,135.2	1,428.6	4,069.4	1,011.2	3,296.1	506.4	3,767.0
LOW-RISE MASONRY	3	1					199.2	253.2	245.7	531.4	143.4	223.8	95.8	286.7	365.0
		2					113.2	67.2	105.3	95.8	8.4	283.5	95.8	244.0	102.2
		3					140.3	75.2	150.5	243.9	691.9	238.7	1,404.9	79.3	262.8
MID-RISE WOOD FRAME	2	1		32.3	26.9	14.7									
		2		11.3	10.4	6.3									
		3		14.3	31.9	32.7									
MID-RISE MASONRY	4	1					99.1	60.6	24.7	136.8	31.5	97.0	31.0	102.1	206.5
		2					56.3	16.1	10.6	24.7	1.9	122.8	31.0	86.9	57.8
		3					69.8	18.0	15.1	62.8	151.8	103.4	455.3	28.2	148.6
MID-RISE REIN. CONC.	6	1		11.7	9.7	11.8									
		2		5.2	3.1	4.9									
		3		6.6	13.4	31.0									
HIGH-RISE MASONRY	5	1		145.7	163.6	213.2									
		2		65.6	96.7	100.5									
		3		84.0	208.1	286.5									
HIGH-RISE REIN. CONC.	8	1	41.3												
		2	24.1												
		3	86.0												
HIGH-RISE STEEL	12	1	25.5												
		2	14.4												
		3	72.1												

3.12 School Buildings

3.12.1 Overview. Over 700 schools were identified in the study area, over one-third of them located in Boston. Schools identified include public and private facilities, high schools, middle schools, primary schools, community colleges, and four-year colleges. Table 3.12a is an inventory of all of the schools in the study area. Table 3.12b lists the student population for public schools (K-12), private schools (K-12), and colleges and universities by community. Boston alone has over 20 four-year colleges, many of which are highly regarded in the academic community. The Massachusetts Institute of Technology (MIT) in Cambridge is one of the premier schools of science and engineering in the country. MIT's excellent research opportunities attract top-name scientists. Harvard University has produced 29 Nobel laureates and more than 25 Pulitzer Prize winners. Six presidents of the United States have been Harvard graduates.

Harvard University is also recognized as the oldest institution of higher learning in the United States. It was founded 16 years after the arrival of the Pilgrims at Plymouth. The university was named for its first benefactor, John Harvard of Charlestown, a young minister who left his library and half of his estate to this institution upon his death in 1638. Harvard now owns and occupies over 450 acres of land and over 400 buildings in Cambridge and in the Longwood and Allston areas of Boston. The buildings of Harvard Yard are old low-rise masonry structures from the early days of the university. Newer buildings are typically of reinforced concrete. The university employs nearly 12,000 people on a full- or part-time basis.

Boston University is another highly recognized school. With 16 schools and colleges, Boston University is the fifth largest independent institution of higher education in the United States. Originating in 1839 as a seminary founded by members of the Methodist Episcopal Church, the schools and colleges of the university were scat-

tered throughout the city as the school began to grow. In 1920, a 15-acre parcel of land on the south bank of the Charles River was purchased, and, after the Second World War (1950), the buildings of a central campus were completed. As adjacent properties were acquired, the remaining schools and colleges were slowly brought to the Charles River Campus, and existing structures were redesigned and refurbished to meet new needs. The majority of the main campus buildings are low- to medium-rise reinforced concrete structures, while a large percentage of the dormitories are row houses (low-rise masonry structures). By 1966, the university was completely consolidated, with the exception of the medical and graduate dentistry schools, which remained at their original locations to form the core of the Boston University Medical Center. Today the 80-acre campus, like many other Boston schools, is an interesting mixture of contemporary and historical architecture.

3.12.2 Engineering Classifications and Replacement Values. The engineering structure classifications for all school buildings and universities are detailed in Table 3.12c. Engineering structure classifications for both public and private schools, kindergarten through grade 12, and colleges and universities were established through sampling. Classification sampling for universities and colleges represents all the facilities found on a campus.

Replacement values for all schools are detailed by cells and seismic hazard zones in Table 3.12d.

TABLE 3.12a
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S 1	ARLINGTON	ARLINGTON CATH.H.S.	16 MEDFORD	NON-PUB.9-12	613				3
S 2	ARLINGTON	ARLINGTON HIGH	869 MASS. AVE.	PUB.9-12	1577				3
S 3	ARLINGTON	BRACKETT	66 EASTERN AVE	PUB.K-6	314				1
S 4	ARLINGTON	CYRUS E DALLIN	185 FLORENCE AVE	PUB.N-6	308				1
S 5	ARLINGTON	ECOLE BILINQUE	17 IRVING	NON-PUB.K-6	70				1
S 6	ARLINGTON	GERMANE LAWRENCE	18 CLAREMONT AVE.	NON-PUB.SP.	47				1
S 7	ARLINGTON	GIBBS JR. HIGH	FOSTER	PUB.7-8	354				3
S 8	ARLINGTON	HARDY	52 LAKE	PUB.K-6	358				3
S 9	ARLINGTON	JOHN A BISHOP	25 COLUMBIA RD.	PUB.K-6	329				1
S 10	ARLINGTON	M NORCROSS STRATTON	180 MOUNTIAN AVE.	PUB.K-6	303				1
S 11	ARLINGTON	OTTOSON JR HIGH	63 ACTON	PUB.7-8	460				1
S 12	ARLINGTON	PIERCE	PARK AVE. EXIT	PUB.K-6	287				1
S 13	ARLINGTON	SCHOOLS FOR CHILDREN	34 WINTER	NON-PUB.SP.	140				3
S 14	ARLINGTON	ST.AGNES	51 MEDFORD	NON-PUB.K-8	454				3
S 15	ARLINGTON	ST.JAMES	10 ACTON	NON-PUB.K-8	148				1
S 16	ARLINGTON	THOMPSON	60 NORTH UNION	PUB.K-6	341				3
S 17	BEDFORD	BEDFORD HIGH	MUDGE WAY	PUB.9-12	891				1
S 18	BEDFORD	JOHN GLENN MIDDLE	MCMAHON AVE.	PUB.6-8	463				1
S 19	BEDFORD	LT ELEAZAER DAVIS	DAVIS RD.	PUB.K-5	344				2
S 20	BEDFORD	LT JOB LANE SCHOOL	SWEETWATER AVE.	PUB.K-5	386				1
S 21	BEDFORD	MIDDLESEX COMM.COLL.	SPRINGS RD.	COMMUNITY COLL.	0				1
S 22	BELMONT	ARLINGTON	115 MILL	NON-PUB.SP.	39				1
S 23	BELMONT	BELMONT DAY	55 DAY SCHOOL LANE	NON-PUB.N-6	176				1
S 24	BELMONT	BELMONT HIGH	221 CONCORD AVE.	PUB.9-12	1161				3
S 25	BELMONT	BELMONT HILL	350 PROSPECT	NON-PUB.7-12	403				1
S 26	BELMONT	CORNERSTONE CHRISTIA	54 BRIGHTON	NON-PUB.1-8	24				3
S 27	BELMONT	DANIEL BUTLER	90 WHITE	PUB.K-5	310				1
S 28	BELMONT	KENDALL NURSERY SCH.	577 BELMONT	NON-PUB.N-K	71				1
S 29	BELMONT	LEARNING CENTER	130 COMMON	NON-PUB.SP.	46				2
S 30	BELMONT	MARY LEE BURBANK	266 SCHOOL	PUB.K-5	205				2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S 31	BELMONT	ROGER E WELLINGTON	121 ORCHARD	PUB.K-5	445				2
S 32	BELMONT	WINN BROOK	97 WATERHOUSE RD.	PUB.K-5	329				3
S 33	BELMONT	WINTHROP L CHENERY	95 WASHINGTON	PUB.6-8	724				2
S 34	BOSTON	ACORN CHILD CARE	214 HARRISON	NON-PUB.N-K	70				3
S 35	BOSTON	ADVENT	17 BRIMMER	NON-PUB.1-6	106				3
S 36	BOSTON	AGASSIZ	20 CHILD	PUB.K-5	712				1
S 37	BOSTON	ALEXANDER HAMILTON	196 STRATHMORE RD	PUB.K-5	311				1
S 38	BOSTON	AMER.INST.OF BANKING	50 CHARLES RIVER PL.	4YR.COLLEGE	0				3
S 39	BOSTON	BAY COVE DAY CARE	260 TREMONT	NON-PUB. SP	18				3
S 40	BOSTON	BAY COVE HIGH SCHOOL	125 LINCOLN	NON-PUB.SP	24				3
S 41	BOSTON	BAY STATE JR.COLLEGE	122 COMMONWEALTH AVE	2YR.ASSOC.DEG.	0				3
S 42	BOSTON	BEACON HILL NURSERY	74 JOY	NON-PUB.N-K	81				2
S 43	BOSTON	BEETHOVEN	5125 WASHINGTON	PUB.K-5	185	MASONRY	LOW	1949	1
S 44	BOSTON	BEREA ELEM	800 MORTON	NON-PUB.K-8	260				1
S 45	BOSTON	BERKLEE COL.OF MUSIC	1140 BOYLSTON ST.	4YR.COLLEGE	0				3
S 46	BOSTON	BLACKSTONE	380 SHAWMUT AVE	PUB.K-5	886				3
S 47	BOSTON	BLESSED SACRAMENT	35 CREIGHTON	NON-PUB.1-8	228				1
S 48	BOSTON	BOSTON ARCHITECTURAL	320 NEWBURY ST.	4YR.COLLEGE	0				3
S 49	BOSTON	BOSTON COLLEGE	CHESTNUT HILL	4YR.COLLEGE	0				2
S 50	BOSTON	BOSTON COLLEGE HIGH	150 MORRISSEY BLVD.	NON-PUB.9-12	1228				3
S 51	BOSTON	BOSTON CONS.OF MUSIC	NO.8 THE FENWAY	4YR.COLLEGE	0				3
S 52	BOSTON	BOSTON CTR FOR BLIND	147 S. HUNTINGTON	NON-PUB.SP.	23				1
S 53	BOSTON	BOSTON HIGH SCHOOL	152 ARLINGTON	PUB.9-12	821				3
S 54	BOSTON	BOSTON LATIN	78 AVE LOUIS PASTEUR	PUB.7-12	2387				3
S 55	BOSTON	BOSTON LATIN ACADEMY	141 IPSWICH	PUB.7-12	1376				1
S 56	BOSTON	BOSTON TECH HIGH	205 TOWNSEND	PUB.9-12	1116				1
S 57	BOSTON	BOSTON UNIVERSITY	765 COMMONWEALTH	4YR.COLLEGE	0				3
S 58	BOSTON	BOSTON'S CHILDRENS	8 WHITTIER PL.	NON-PUB.N-K	27				3
S 59	BOSTON	BRIGHTON HIGH	25 WARREN	PUB.9-12	1147	MASONRY	LOW	1939	2
S 60	BOSTON	CAMP WEIDKO	25 HUNTINGTON	NON-PUB.SP.	0				3

TABLE 3.12a (cont.)

SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S 61	BOSTON	CARDINAL CUSHING H.S	50 WEST BROADWAY	NON-PUB.9-12	415				3
S 62	BOSTON	CARTER DEVEL.DAYCARE	396 NORTHAMPTON	PUB.UG	27				3
S 63	BOSTON	CATHEDRAL GRAMMAR	595 HARRISON AVE	NON-PUB.1-8	179				3
S 64	BOSTON	CATHEDRAL HIGH	74 UNION PARK	NON-PUB.9-12	361	MASONRY	LOW	1930	3
S 65	BOSTON	CATHEDRAL MEMORIAL H	235 BAKER ST.	NON-PUB.9-12	1019				1
S 66	BOSTON	CATHERINE LABOURE CO	2120 DORCHESTER AVE	2YR.ASSOC.DEG.	0				3
S 67	BOSTON	CHAMBERLANE JR.COLL	128 COMMONWEALTH AVE	2YR.ASSOC.DEG.	0				3
S 68	BOSTON	CHARLES E MACKEY	90 WARREN AVE	PUB.6-8	460				3
S 69	BOSTON	CHARLES H TAYLOR	1060 MORTON ST.	PUB.K-5	503				1
S 70	BOSTON	CHARLES SUMNER	15 BASILE	PUB.K-5	462				2
S 71	BOSTON	CHARLESTOWN HIGH	240 MEDFORD	PUB.9-12	1200				2
S 72	BOSTON	CHRIS COLUMBUS CATH.	20A TILESTON	NON-PUB.9-12	532				1
S 73	BOSTON	CLARENCE R EDWARDS	28 WALKER	PUB.6-8	516				2
S 74	BOSTON	COMMONWEALTH	151 COMMONWEALTH AVE	NON-PUB.9-12	135				3
S 75	BOSTON	COMPASS	115 WARREN	NON-PUB.UG	17				1
S 76	BOSTON	COPLEY SQ. HIGH	150 NEWBURY	PUB.9-12	571	MASONRY	MED.	1924	3
S 77	BOSTON	COTTING	241 ST.BOTOLPH	NON-PUB. SP	96				3
S 78	BOSTON	CRITTENTON HASTINGS	10 PERTHSHIRE AVE.	NON-PUB.SP.	0				2
S 79	BOSTON	CURTIS GUILD	5 ASHLEY	PUB.K-5	239				2
S 80	BOSTON	DANTE ALIGHIERI	37 GROVE	PUB.1-5	170				2
S 81	BOSTON	DAUGHTERS OF ST. PAU	50 ST. PAUL'S AVE.	NON-PUB.	0				3
S 82	BOSTON	DAVID A ELLIS	302 WALNUT AVE.	PUB.K-5	479				1
S 83	BOSTON	DEARBORN	35 GREENVILLE	PUB.6-8	394				3
S 84	BOSTON	DENNIS C HALEY	570 AM.LEGION HWY.	PUB.N-7	312				3
S 85	BOSTON	DON BOSCO TECH.HIGH	300 TREMONT	NON-PUB.9-12	825				3
S 86	BOSTON	DONALD MCKAY	122 COTTAGE	PUB.K-5	415				3
S 87	BOSTON	DORCHESTER HIGH	9 PEACEVALE RD	PUB.10-12	996				1
S 88	BOSTON	DORCHESTER HOUSE	1353 DORCHESTER AVE	NON-PUB.	0				3
S 89	BOSTON	E.BOSTON CENTRAL CAT	69 LONDON	NON-PUB.K-8	0				3
S 90	BOSTON	EAST BOSTON HIGH	86 WHITE	PUB.9-12	1083	MASONRY	LOW	1924	2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S 91	BOSTON	EDWARD EVERETT	71 PLEASANT	PUB.K-5	261				3
S 92	BOSTON	ELIHU GREENWOOD	612 METROPOLITAN AVE	PUB.K-5	454				1
S 93	BOSTON	ELIOT ELEMENTARY	16 CHARTER	PUB.K-5	224				3
S 94	BOSTON	ELLIS MENDELL	164 SCHOOL	PUB.K-5	230				2
S 95	BOSTON	EMERSON COLLEGE	148 BEACON ST.	4YR.COLLEGE	0				3
S 96	BOSTON	EMILY A FIFIELD	25 DUNBAR AVE.	PUB.K-5	438	MASONRY	LOW	1930's0	1
S 97	BOSTON	EMMANUEL COLLEGE	NO.400 THE FENWAY	4YR.COLLEGE	0				3
S 98	BOSTON	EMMANUEL HOUSE	11 NEWCOMB	NON-PUB.K	43				3
S 99	BOSTON	F.D.ROOSEVELT SCHOOL	95 NEEDHAM RD	PUB.K-5	206				1
S100	BOSTON	FARRAGUT	10 FENWOOD RD.	PUB.K-5	261				3
S101	BOSTON	FISHER JR.COLLEGE	118 BEACON ST.	2YR.ASSOC.DEG.	0				3
S102	BOSTON	FRANCIS PARKMAN	25 WALK HILL	PUB.K-5	199				1
S103	BOSTON	FRANK V THOMPSON MID	100 MAXWELL	PUB.6-8	393				1
S104	BOSTON	FRANKLIN INST.OF BOS	41 BERKELEY ST.	2YR.ASSOC.DEG.	0				3
S105	BOSTON	GATE OF HEAVEN ELEM.	609 E.FOURTH	NON-PUB.1-8	523				2
S106	BOSTON	GEORGE H CONLEY	450 POPLAR	PUB.K-5	179				1
S107	BOSTON	GREATER BOSTON YMCA	1137 RIVER	NON-PUB.	0				1
S108	BOSTON	GROVER CLEVELAND	11 CHARLES	PUB.6-8	971				1
S109	BOSTON	HARRIET A BALDWIN	121 COREY RD.	PUB.K-5	299				1
S110	BOSTON	HARVARD-KENT	50 BUNKER HILL	PUB.K-5	451				3
S111	BOSTON	HAYDEN-MORGAN MEM.	21 QUEEN	NON-PUB.SP.	22				1
S112	BOSTON	HEMENWAY	MILLSTONE RD.	PUB.N-5	112				1
S113	BOSTON	HENRY GREW	40 GORDON AVE.	PUB.K-5	221				1
S114	BOSTON	HENRY L HIGGINSON	160 HARRISHOF	PUB.K-5	180				1
S115	BOSTON	HOLDEN SCHOOL INC	8 PEARL	NON-PUB.SP.	0				2
S116	BOSTON	HOLLOW REED SCHOOL	93 SEDWICK	NON-PUB.	0				2
S117	BOSTON	HOLY CHILDHOOD	420 POND	NON-PUB.N-8	0				1
S118	BOSTON	HOLY NAME	535 W.ROXBURY PKWY.	NON-PUB.1-8	622	MASONRY	LOW	1952	1
S119	BOSTON	HORACE MANN	40 ARMINGTON ST.	PUB.SP	149				2
S120	BOSTON	HUBERT H. HUMPHREY	55 NEW DUDLEY	PUB.	0				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S121	BOSTON	HUGH ROE ODONNELL	33 TRENTON	PUB.K-5	261				2
S122	BOSTON	HYDE PARK ACADEMY	14 EVERETT ST.	NON-PUB.1-12	205				1
S123	BOSTON	HYDE PARK HIGH SCH.	655 METROPOLITAN AVE	PUB.9-12	980	MASONRY	LOW	1946	1
S124	BOSTON	INSTITUTIONAL SCHOOL	31 ST.JAMES AVE.	STATE SCH. K-14	782				3
S125	BOSTON	ITALIAN HM FOR CHILD	1125 CENTER	NON-PUB.SP.	0				1
S126	BOSTON	JACKSON MANN	40 ARMINGTON ST.	PUB.K-5	702				2
S127	BOSTON	JAMAICA PLAIN DAY	962 PARKER	NON-PUB.N-K	0				1
S128	BOSTON	JAMAICA PLAIN HIGH	144 MCBRIDE	PUB.9-12	853				1
S129	BOSTON	JAMES A GARFIELD ELE	95 BEECHCROFT	PUB.K-5	209				3
S130	BOSTON	JAMES A HENNIGAN	200 HEATH	PUB.K-5	710				1
S131	BOSTON	JAMES CONDON ELEMEN.	200 D	PUB.K-5	784				3
S132	BOSTON	JAMES J. CHITTICK	154 RUSKINDALE RD.	PUB.K-5	397				1
S133	BOSTON	JAMES M CURLEY	PERSHING RD.	PUB.K-5	324				1
S134	BOSTON	JAMES OTIS	218 MARION	PUB.K-8	347				3
S135	BOSTON	JAMES P TIMILTY	205 ROXBURY	PUB.6-8	424				1
S136	BOSTON	JEREMIAH E BURKE HS	60 WASHINGTON	PUB.9-12	700				1
S137	BOSTON	JOHN CHEVERUS MIDDLE	10 MOORE	PUB.6-8	168				3
S138	BOSTON	JOHN D PHILBRICK	40 PHILBRICK	PUB.K-5	126				1
S139	BOSTON	JOHN F. KENNEDY	7 BOLSTER	PUB.K-5	432				1
S140	BOSTON	JOHN MARSHALL	35 WESTVILLE	PUB.K-5	832				1
S141	BOSTON	JOHN P HOLLAND	85 OLNEY	PUB.K-5	869				1
S142	BOSTON	JOHN W MCCORMACK	315 MT.VERNON ST.	PUB.6-8	565				3
S143	BOSTON	JOHN WINTHROP	35 BROOKFORD	PUB.K-5	226				1
S144	BOSTON	JOSEPH J HURLEY	70 WORCHESTER ST.	PUB.K-5	333				3
S145	BOSTON	JOSEPH LEE	155 TALBOT AVE	PUB.K-5	472				1
S146	BOSTON	JOSEPH M. BARNES	127 MARION	PUB.6-8	570				2
S147	BOSTON	JOSEPH P MANNING	130 LOUDERS LN	PUB.K-5	173				1
S148	BOSTON	JOSEPH P TYNAN	650 E.FOURTH	PUB.K-5	317				2
S149	BOSTON	JOSIAH QUINCY	885 WASHINGTON	PUB.K-5	729				3
S150	BOSTON	JOYCE KILMER	35 BAKER	PUB.K-5	240				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S151	BOSTON	JULIE'S CHILDREN'S	200 D ST.	NON-PUB.N-K	0				3
S152	BOSTON	JUSTICE RESOURCE INC	132 BOYLSTON	NON-PUB.	0				3
S153	BOSTON	KENNEDY MEM. HOSPTL	WARREN	NON-PUB.SP.	85				2
S154	BOSTON	LABOURE CTR.NURSERY	371 W.FOURTH ST.	NON-PUB.N-K	28				3
S155	BOSTON	LANG & COGNITVE DEV.	11 WYMAN	NON-PUB.SP.	25				1
S156	BOSTON	LEWIS MIDDLE SCHOOL	131 WALNUT AVE	PUB.6-8	202				1
S157	BOSTON	LITTLE HOUSE ALTERN.	275 EAST COTTAGE	NON-PUB.SP.	11				3
S158	BOSTON	LOG	222 BOWDOIN ST.	NON-PUB.6-12	0				1
S159	BOSTON	LONGFELLOW	885 SOUTH	PUB.K-5	244				2
S160	BOSTON	LT.JOSEPH KENNEDY JR	17 HALE	NON-PUB.K-8	318				1
S161	BOSTON	LUCY STONE	22 REGINA RD.	PUB.K-5	218				1
S162	BOSTON	MA.COL.PHARM.& ALL.H	179 LONGWOOD AVE.	4YR.COLLEGE	0				1
S163	BOSTON	MADISON PARK HIGH	55 NEW DUDLEY ST.	PUB.9-12	1890				3
S164	BOSTON	MANASSAH E BRADLEY	110 BEACHVIEW RD.	PUB.K-5	230				2
S165	BOSTON	MANVILLE	295 LONGWOOD AVE.	NON-PUB.-SP	67				3
S166	BOSTON	MARGRET FULLER	25 GLEN RD.	PUB.K-5	245				1
S167	BOSTON	MARIO URANA HARBOR	312 BORDER	PUB.7-12	1018				2
S168	BOSTON	MARTIN LUTHER KING	77 LAWRENCE AVE	PUB.6-8	553				1
S169	BOSTON	MARY E CURLEY MIDDLE	493 CENTRE ST	PUB.6-8	730				1
S170	BOSTON	MASS.COLL.OF ART	364 BROOKLINE AVE.	STATE COLLEGE	0				1
S171	BOSTON	MASS.GENERAL HOS.	FRUIT ST.	4YR.COLLEGE	0				3
S172	BOSTON	MATHER	MEETING HOUSE HILL	PUB.K-5	539				1
S173	BOSTON	MATTAHUNT	100 HEBRON ST.	PUB.K-5	736				1
S174	BOSTON	MAURICE J TOBIN	40 SMITH	PUB.K-5	529				1
S175	BOSTON	MICHAEL J PERKINS	50 BURKE	PUB.K-5	240				3
S176	BOSTON	MICHELANGELO MIDDLE	70 CHARTER	PUB.6-8	268				1
S177	BOSTON	MISSION CHURCH HIGH	69 ALLEGHANY	NON-PUB.9-12	243				1
S178	BOSTON	MOST PRECIOUS BLOOD	1206 HYDE PARK AVE.	NON-PUB.1-8	280				1
S179	BOSTON	MOZART	236 BEECH	PUB.K-5	165				2
S180	BOSTON	MSGR.RYAN MEMORIAL	11 MAYHEW	NON-PUB.9-12	332				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S181	BOSTON	MT.ST.JOSEPH ACADEMY	617 CAMBRIDGE	NON-PUB.9-12	646				2
S182	BOSTON	N.E.HOME CHILD CARE	161 SO.HUNTINGTON	NON-PUB.SP.	40				1
S183	BOSTON	N.ENG.INST.APPL.ARTS	656 BEACON ST.	2YR.ASSOC.DEG.	0				3
S184	BOSTON	NATHAN HALE	51 CEDAR ST	PUB.K-5	208				1
S185	BOSTON	NAZARETH CHILD CTR.	420 POND	NON-PUB.SP.	56				1
S186	BOSTON	NEW ENG.COL.OF OPTOM	424 BEACON ST.	4YR.COLLEGE	0				3
S187	BOSTON	NEW ENG.CONS.MUSIC	290 HUNTINGTON AVE	4YR.COLLEGE	0				3
S188	BOSTON	NEW ENG.SCH.OF LAW	154-6 STUART ST.	4YR.COLLEGE	0				3
S189	BOSTON	NEWBURY JR.COLLEGE	921 BOYLSTON ST.	2YR.ASSOC.DEG.	0				3
S190	BOSTON	NEWMAN PREPARATORY	245 MARLBOROUGH	NON-PUB.9-13	352				3
S191	BOSTON	NORTH BENNET ST. SCH	39 NORTH BENNET	NON-PUB.N-K	24				1
S192	BOSTON	NORTHEASTERN UNIV.	360 HUNTINGTON AVE.	4YR.COLLEGE	0				3
S193	BOSTON	OLIVER HAZARD PERRY	745 E.SEVENTH	PUB.K-5	134				3
S194	BOSTON	OLIVER WENDELL HOLME	40 SCHOOL	PUB.6-8	383				1
S195	BOSTON	OUR LADY OF LOURDES	54 BROOKSIDE AVE	NON-PUB.K-8	278				3
S196	BOSTON	OUR LADY OF PERPETUA	94 ST. ALPHONSUS	NON-PUB.1-8	170				1
S197	BOSTON	OUR LADY OF PRESENTA	3 TREMONT	NON-PUB.K-8	242				2
S198	BOSTON	PARKSIDE	215 FOREST HILL	NON-PUB.K-6	391				1
S199	BOSTON	PARKWAY ACADEMY	5-7 VFW PARKWAY	NON-PUB.1-8	179				1
S200	BOSTON	PATRICK F GAVIN MID.	215 DORCHESTER	PUB.6-8	494				1
S201	BOSTON	PATRICK F LYNDON	140 RUSSETT RD	PUB.K-5	186				1
S202	BOSTON	PATRICK J KENNEDY	343 SARATOGA	PUB.K-5	212				3
S203	BOSTON	PATRICK OHEARN	1669 DORCHESTER AVE	PUB.K-5	221				1
S204	BOSTON	PAUL A DEVER	325 MT. VERNON	PUB.K-5	533				3
S205	BOSTON	PAULINE AGASSIZ SHAW	429 NORFOLK	PUB.K-5	295				1
S206	BOSTON	PHINEAS BATES	426 BEECH	PUB.K-5	265				2
S207	BOSTON	PHYLLIS WHEATLY MID.	20 KEARSARGE AVE	PUB.6-8	333				3
S208	BOSTON	PINE MANOR COLLEGE	400 HEATH ST.	4YR.COLLEGE	0				1
S209	BOSTON	PROJECT EISEI	85 EAST NEWTON	NON-PUB.SP.	32				3
S210	BOSTON	QUINCY E DICKERMAN	206 MAGNOLIA	PUB.K-5	346				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S211	BOSTON	RAFAEL HERNANDEZ	370 COLUMBIA RD	PUB.K-5	194				3
S212	BOSTON	RALPH WALDO EMERSON	6 SHIRLEY	PUB.K-5	226				1
S213	BOSTON	RICHARD J MURPHY	1 WORRELL	PUB.K-5	726				3
S214	BOSTON	RIVER ST. SCHOOL	1137 RIVER	NON-PUB.SP.	30				1
S215	BOSTON	ROBERT GOULD SHAW M	20 MT VERNON	PUB.6-8	272				1
S216	BOSTON	ROBERT WHITE SCHOOL	GOVT. CENTER	NON-PUB.SP.	23				2
S217	BOSTON	ROGER CLAP	35 HARVEST	PUB.K-5	179				3
S218	BOSTON	ROXBURY COMMUN.COLL.	625 HUNTINGTON AVE.	COMMUNITY COLL.	0				3
S219	BOSTON	ROXBURY LATIN	101 ST.THERESA AVE.	NON-PUB.7-12	262				1
S220	BOSTON	SACRED HEART	1035 CANTERBURY	NON-PUB.1-8	501				1
S221	BOSTON	SAMUEL ADAMS	165 WEBSTER	PUB.K-5	247				2
S222	BOSTON	SAMUEL W MASON	150 NORFOLK AVE	PUB.K-5	119				3
S223	BOSTON	SARAH GREENWOOD	189 GLENWAY	PUB.K-5	479				1
S224	BOSTON	SHAW PREP.	883 BOYLSTON	NON-PUB.9-13	50				3
S225	BOSTON	SIMMONS COLLEGE	NO.300 THE FENWAY	4YR.COLLEGE	0				3
S226	BOSTON	SISTER CLARA MUHAMME	150 MAGNOLIA	NON.PUB	0				1
S227	BOSTON	SO.BOSTON HEIGHTS	486 E.THIRD	NON-PUB.1-12	219				2
S228	BOSTON	SOLOMON LEWENBERG M	20 OUTLOOK RD.	PUB.6-8	368				1
S229	BOSTON	SOUTH BOSTON HIGH	95 G	PUB.9-12	1068				2
S230	BOSTON	ST.AMBROSE	23 LEONARD	NON-PUB.K-8	0				3
S231	BOSTON	ST.ANDREW	86 WACHUSETT	NON-PUB.1-8	280				1
S232	BOSTON	ST.ANGELA	120 BABSON	NON-PUB.1-8	232				1
S233	BOSTON	ST.ANN	241 NEPONSET AVE.	NON-PUB.1-8	468	MASONRY	LOW	1926	1
S234	BOSTON	ST.ANNE	20 COMO RD.	NON-PUB.1-8	292				2
S235	BOSTON	ST.ANTHONY	57 HOLTON	NON-PUB.1-8	189				1
S236	BOSTON	ST.AUGUSTINE ELEM.	209 E	NON-PUB.1-8	0				3
S237	BOSTON	ST.BRENDAN	29 RITA RD.	NON-PUB.1-8	279				3
S238	BOSTON	ST.BRIGID	866 E.BROADWAY	NON-PUB.1-8	345	MASONRY	LOW	1933	2
S239	BOSTON	ST.CATHERINE	13 TUFTS	NON-PUB.1-8	236				3
S240	BOSTON	ST.CLARE HIGH	190 CUMMINS HWY.	NON-PUB.9-12	569	MASONRY	LOW	1956	1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S241	BOSTON	ST.COLUMBRILLE ELEM	25 ARLINGTON	NON-PUB.1-8	219	MASONRY	LOW	1900	2
S242	BOSTON	ST.COLUMBRILLE HIGH	25 ARLINGTON	NON-PUB.9-12	240	MASONRY	LOW	1900	2
S243	BOSTON	ST.DOMINIC SAVIO H.S	BYRON & HORACE	NON-PUB.9-12	439				3
S244	BOSTON	ST.FRANCES DESALES	340 BUNKER HILL	NON-PUB.K-8	260				2
S245	BOSTON	ST.GREGORY ELEM.	2214 DORCHESTER AVE.	NON-PUB.K-8	516				3
S246	BOSTON	ST.GREGORY HIGH	2214 DORCHESTER AVE.	NON-PUB.9-12	400	MASONRY	LOW	1956	3
S247	BOSTON	ST.JOHN	9 MOON	NON-PUB.K-8	249				3
S248	BOSTON	ST.JOHN'S SEMINARY	127 LAKE ST.	4YR.COLLEGE	0				2
S249	BOSTON	ST.JOSEPH	18 HULBERT	NON-PUB.K-8	0				1
S250	BOSTON	ST.KEVIN	516 COLUMBIA	NON-PUB.K-8	408				1
S251	BOSTON	ST.LAZARUS	67 ASHLEY	NON-PUB.1-8	0				2
S252	BOSTON	ST.MARGARET	790 COLUMBIA	NON-PUB.1-8	384				1
S253	BOSTON	ST.MARK	197 CENTRE AVE.	NON-PUB.1-8	586				1
S254	BOSTON	ST.MARY	666 DORCHESTER AVE.	NON-PUB.1-8	195				3
S255	BOSTON	ST.MARY STAR OF THE	58 MOORE	NON-PUB.1-8	0				3
S256	BOSTON	ST.MATTHEW	29 STANTON	NON-PUB.1-8	0				1
S257	BOSTON	ST.PATRICK ELEM.	140 MT.PLEASANT AVE.	NON-PUB.1-8	0				1
S258	BOSTON	ST.PETER	518 E. SIXTH ST.	NON-PUB.K-8	302				3
S259	BOSTON	ST.PETER	294 BOWDOIN	NON-PUB.1-8	224				1
S260	BOSTON	ST.THERESA	40 ST.THERESA AVE.	NON-PUB.1-8	708				1
S261	BOSTON	ST.WILLIAM	100 SAVIN HILL AVE.	NON-PUB.1-8	310				3
S262	BOSTON	SUFFOLK UNIVERSITY	BEACON HILL	4YR.COLLEGE	0				2
S263	BOSTON	SWEENEY NURSERY & KD	11 ASHMONT	NON-PUB.N-K	0				1
S264	BOSTON	TARTTS DAY CARE CTR.	2 HOLBURN TERACE	NON-PUB.N-K	17				1
S265	BOSTON	THE ENGLISH HIGH	77 AVE LOUIS PASTEUR	PUB.9-12	1652				3
S266	BOSTON	THE KINGSLEY	30 FAIRFIELD	NON-PUB.UG.	57				3
S267	BOSTON	THE WINSOR	PILGRIM RD.	NON-PUB.5-12	362				3
S268	BOSTON	THEODORE ROOSEVELT M	61 SCHOOL	PUB.6-8	243				1
S269	BOSTON	THOMAS A EDISON JR H	60 GLENMONT RD.	PUB.7-9	543				2
S270	BOSTON	THOMAS GARDNER	BRENTWOOD & ATHOL	PUB.K-5	419				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S271	BOSTON	THOMAS J KENNY	19 OAKTON AVE	PUB.K-5	244				1
S272	BOSTON	TILESTON	108 BABSON	PUB.UG	2				1
S273	BOSTON	UNIVERSITY OF MASS.	HARBOR CAMPUS	STATE COLLEGE	0				3
S274	BOSTON	VESTA SCHOOL	55 CUMMINGS HWY	NON-PUB.N	0				1
S275	BOSTON	WARREN-PRESCOTT	50 SCHOOL	PUB.K-5	480				1
S276	BOSTON	WASHINGTON IRVING M.	114 CUMMINS HWY	PUB.6-8	633				1
S277	BOSTON	WEE CARE	215 FOREST HILL	NON-PUB.N-K	41				1
S278	BOSTON	WENTWORTH INST.TECH.	550 HUNTINGTON AVE	4YR.COLLEGE	0				3
S279	BOSTON	WEST ROXBURY SCHOOL	1205 VFW PARKWAY	PUB.9-12	1425				1
S280	BOSTON	WHEELOCK COLLEGE	NO.200 RIVERWAY	4YR.COLLEGE	0				3
S281	BOSTON	WILLIAM E RUSSELL	750 COLUMBIA	PUB.K-5	355				1
S282	BOSTON	WILLIAM H TAFT MID	20 WARREN ST.	PUB.6-8	554				2
S283	BOSTON	WILLIAM MCKINLEY	50 ST. MARY'S	PUB.UG	313				3
S284	BOSTON	WINSHIP ELEMENTARY	54 DIGHTON	PUB.K-5	334				2
S285	BOSTON	WM B ROGERS MIDDLE	15 EVERETT	PUB.6-8	569				1
S286	BOSTON	WM E ENDICOTT	2 MCLELLAN	PUB.K-5	181				1
S287	BOSTON	WM.ELLERY CHANNING	33 SUNNYSIDE	PUB.K-5	252				1
S288	BOSTON	WM.H OHRENBERGER	175 W BOUNDARY RD.	PUB.K-5	499				1
S289	BOSTON	WM.MONROE TROTTER	135 HUMBOLDT AVE	PUB.K-5	688				1
S290	BOSTON	WOODROW WILSON MID.	18 CROFTLAND AVE	PUB.6-8	667				1
S291	BROOKLINE	BEAVER COUNTRY DAY	791 HAMMOND	NON-PUB.5-13	365				1
S292	BROOKLINE	BROOKLINE HIGH	115 GREENOUGH	PUB.9-12	2168				1
S293	BROOKLINE	COMM. PRESCHOOL THER	16 HURD RD.	NON-PUB.SP.	21				3
S294	BROOKLINE	DEXTER SCHOOL	20 NEWTON	NON-PUB.1-8	300				1
S295	BROOKLINE	EDITH C BAKER	205 BEVERLY RD	PUB.K-8	408				1
S296	BROOKLINE	EDNA STEIN ACADEMY	279 CYPRESS	NON-PUB.SP.	36				1
S297	BROOKLINE	EDWARD DEVOTION	345 HARVARD	PUB.K-8	749				2
S298	BROOKLINE	HEATH	100 ELIOT	PUB.K-8	314				1
S299	BROOKLINE	HEBREW COLLEGE	43 HAWES ST.	4YR.COLLEGE	0				3
S300	BROOKLINE	HELENIC COLLEGE	50 GODDARD AVE.	4YR.COLLEGE	0				1

TABLE 3.12a (cont.)

SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S301	BROOKLINE	JOHN D RUNKLE	50 DRUCE	PUB.K-8	392				1
S302	BROOKLINE	LAWRENCE	27 FRANCIS	PUB.K-8	405				3
S303	BROOKLINE	MAIMONIDES	PHILBRICK RD.	NON-PUB.N-12	461				1
S304	BROOKLINE	MASS ASSOC FOR THE B	200 IVY	NON.PUB.SP.	26				3
S305	BROOKLINE	MICHAEL DRISCOLL	64 WESTBOURNE TERR.	PUB.K-8	382				1
S306	BROOKLINE	MONTROSE SCHOOL	129 FISHER AVE.	NON-PUB.7-12	66				1
S307	BROOKLINE	N.E.HEBREW ACADEMY	9 PRESCOTT	NON-PUB.N-12	240				3
S308	BROOKLINE	NEW PERSPECTIVES	74 GREEN	NON-PUB.SP.	39				2
S309	BROOKLINE	PIERCE	50 SCHOOL	PUB.K-8	546				3
S310	BROOKLINE	RAINBOW PRESCHOOL	240 BABCOCK	NON-PUB.N	18				3
S311	BROOKLINE	ST.MARY OF THE ASSUM	75 HARVARD	NON-PUB.1-8	250				3
S312	BROOKLINE	THE PARK	171 GODDARD AVE.	NON-PUB.N-9	482				1
S313	BROOKLINE	THERAPUTIC CENTER	16 HURD RD.	NON-PUB.SP.	30				3
S314	BROOKLINE	WARREN CTR. SUMMER	11 PIERCE	NON-PUB.SP.	0				3
S315	BROOKLINE	WILLIAM H LINCOLN	194 BOYLSTON	PUB.K-8	324				1
S316	CAMBRIDGE	ADL MGMT.EDUC.INST.	ACORN PARK	4YR.COLLEGE	0				3
S317	CAMBRIDGE	AGASSIZ	28 SACRAMENTO	PUB.K-8	259				3
S318	CAMBRIDGE	APPLE SCHOOL	145 BRATTLE	NON.PUB.N-8	73				2
S319	CAMBRIDGE	BLESSED SACRAMENT	12 CPL MCTERNAN	NON-PUB.1-8	122				3
S320	CAMBRIDGE	BOSTON ARCH CHOIR	29 MT.AUBURN	NON-PUB.5-8	48				3
S321	CAMBRIDGE	BUCKINHAM,BROWNE,&	GERRY'S LANDING RD.	NON-PUB.K-12	918				3
S322	CAMBRIDGE	CAM.COL/INST OPEN ED	15 MIFFLIN PLACE	4YR.COLLEGE	0				3
S323	CAMBRIDGE	CAMB RINDGE & LATIN	459 BROADWAY	PUB.9-12	2693				3
S324	CAMBRIDGE	CAMBRIDGE FRIENDS	5 CADBURY RD.	NON-PUB.K-8	201				3
S325	CAMBRIDGE	CAMBRIDGE MONTESSORI	161 GARDEN	NON-PUB.UG.	140				3
S326	CAMBRIDGE	CASTLE SCHOOL	293 HARVARD	NON.PUB.SP.	6				3
S327	CAMBRIDGE	CENTRAL SCHOOL	43 ESSEX	NON-PUB.N-K	0				3
S328	CAMBRIDGE	CHARLES G HARRINGTON	850 CAMBRIDGE	PUB.K-8	666				3
S329	CAMBRIDGE	CHRLES RIVER ACADEMY	5 CLINTON	NON-PUB.UG.	23				3
S330	CAMBRIDGE	EPISCOPAL DIVINITY	99 BRATTLE ST.	4YR.COLLEGE	0				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S331	CAMBRIDGE	FARR ACADEMY	71 PEARL	NON-PUB.UG.	31				3
S332	CAMBRIDGE	FAYERWEATHER STREET	74R FAYERWEATHER	NON-PUB.N-8	123				2
S333	CAMBRIDGE	FLETCHER	89 ELM	PUB.K-8	382				3
S334	CAMBRIDGE	GRAHAM/PARKS NEW ALT	15 UPTON	PUB.K-8	349				3
S335	CAMBRIDGE	HAGGERTY	110 CUSHING	PUB.K-6	114				3
S336	CAMBRIDGE	HARVARD UNIVERSITY	MASS. AVE.	4YR.COLLEGE	0				3
S337	CAMBRIDGE	IMMALCULATE CONCEPTI	45 MATIGNON RD.	NON-PUB.K-8	147				2
S338	CAMBRIDGE	JOHN M TOBIN	197 VASSAL LN	PUB.K-8	613				3
S339	CAMBRIDGE	KING	100 PUTMAN	PUB.K-8	521				3
S340	CAMBRIDGE	LESLEY COLLEGE	29 EVERETT ST.	4YR.COLLEGE	0				3
S341	CAMBRIDGE	LONGFELLOW	359 BROADWAY	PUB.K-8	459				3
S342	CAMBRIDGE	M E FITZGERALD	70 RINDGE AVE	PUB.K-8	445				3
S343	CAMBRIDGE	M.I.T.	77 MASSACHUSETTS AVE	4YR.COLLEGE	0				3
S344	CAMBRIDGE	MANTER HALL	71 MT.AUBURN	NON-PUB.9-12	36				3
S345	CAMBRIDGE	MATIGNON HIGH	1 MATIGNON RD.	NON-PUB.9-12	755				2
S346	CAMBRIDGE	MORSE	40 GRANITE	PUB.K-8	342				3
S347	CAMBRIDGE	N.CAMBRIDGE CATH.H.S	40 NORRIS	NON-PUB.9-12	343				3
S348	CAMBRIDGE	PEABODY	44 LINNAEAN	PUB.K-8	411				3
S349	CAMBRIDGE	RADCLIFFE CHILD CARE	APPIAN WAY	NON-PUB.N-K	58				3
S350	CAMBRIDGE	RADCLIFFE COLLEGE	10 GARDEN	4YR.COLLEGE	0				3
S351	CAMBRIDGE	ROBERT F KENNEDY	158 SPRING	PUB.K-8	304				3
S352	CAMBRIDGE	ROBERTS	225 WINDSOR	PUB.K-8	310				3
S353	CAMBRIDGE	SCHOOLS FOR CHILDREN	36 CONCORD AVE.	NON.PUB.N	34				3
S354	CAMBRIDGE	SHADY HILL	178 COOLIDGE HILL	NON-PUB.N-9	471				3
S355	CAMBRIDGE	ST.JOHN THE EVANGELI	122 RINDGE AVE.	NON-PUB.K-8	143				3
S356	CAMBRIDGE	ST.PETER ELEMENTARY	96 CONCORD AVE.	NON-PUB.K-8	213				2
S357	CAMBRIDGE	THE NEW PREPARATORY	113 BRATTLE	NON-PUB.7-12	69				3
S358	CAMBRIDGE	WESTON COL.THEOLOGY	20 SUMMER RD.	4YR.COLLEGE	0				3
S359	CHELSEA	ASSUMPTION	49 CLARK AVE.	NON-PUB.1-8	173				3
S360	CHELSEA	CHELSEA HIGH	12 CLARK AVE	PUB.9-12	1014				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S361	CHELSEA	MARY C BURKE	SPENCER AVE	PUB.K-6	220				3
S362	CHELSEA	PRATTVILLE	WASHINGTON AVE	PUB.K-5	222				2
S363	CHELSEA	SHORTLEFF ELEMENTARY	76 CONGRESS AVE	PUB.K-6	900				2
S364	CHELSEA	ST.ROSE ELEM.	580 BROADWAY	NON-PUB.1-8	417				2
S365	CHELSEA	ST.ROSE HIGH	580 BROADWAY	NON-PUB.9-12	188				2
S366	CHELSEA	ST.STANISLAUS	179 CHESTNUT	NON-PUB.1-8	163				3
S367	CHELSEA	WILLIAMS ELEMENTARY	WALNUT	PUB.K-6	476				3
S368	CHELSEA	WILLIAMS JR HIGH	WALNUT	PUB.7-8	547				3
S369	DEDHAM	AVERY	123 HIGH	PUB.K-6	326				1
S370	DEDHAM	CENTRAL 6	WHITING AVE.	PUB.6	114				1
S371	DEDHAM	COMMUNITY PRE-SCHOOL	671 HIGH ST.	NON-PUB.N-K	46				1
S372	DEDHAM	DEDHAM COUNTRY DAY	90 SANDY VALLEY RD.	NON-PUB.K-8	216				1
S373	DEDHAM	DEDHAM HIGH	WHITING AVE	PUB.9-12	1196				1
S374	DEDHAM	GREENLODGE	GREENLODGE	PUB.K-6	373				1
S375	DEDHAM	HARLFINGER KDG.	16 R WORTHINGTON	NON-PUB.N-K	47				1
S376	DEDHAM	JUNIOR HIGH	WHITING AVE	PUB.7-8	561				1
S377	DEDHAM	NOBLE & GREENDOUGH	507 BRIDGE	NON-PUB.7-12	427				1
S378	DEDHAM	OAKDALE	CEDAR	PUB.K-6	387				1
S379	DEDHAM	RIVERDALE	NEEDHAM	PUB.K-6	317				1
S380	DEDHAM	THE MACARHTUR	20 PARK	NON-PUB.K-8	15				2
S381	DEDHAM	URSULINE ACADEMY	65 LOWDER	NON-PUB.7-12	398				2
S382	EVERETT	ALBERT N LEWIS	FLOYD	PUB.6	109				2
S383	EVERETT	ALBERT PARLIN JR HIG	587 BROADWAY	PUB.8	765				2
S384	EVERETT	CENTRE	337 BROADWAY	PUB.6	469				2
S385	EVERETT	CHAPMAN NURSERY KDG.	20 HANCOCK	NON-PUB.N-K	27				2
S386	EVERETT	DEVENS	CHURCH	PUB.6	290				2
S387	EVERETT	EDWARD EVERETT HALE	80 GLENDALE	PUB.K-6	267				2
S388	EVERETT	EVERETT HIGH	548 BROADWAY	PUB.9-12	1330				2
S389	EVERETT	GEORGE G HAMILTON	28 NICHOLS	PUB.K-6	291				2
S390	EVERETT	HORACE MANN	45 PROSPECT	PUB.K-6	199				2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S391	EVERETT	IMMACULATE CONCEPTIO	51 SUMMER	NON-PUB.1-8	0				2
S392	EVERETT	LAFAYETTE	SHUTE	PUB.K-6	349				2
S393	EVERETT	OUR LADY OF GRACE	190 NICHOLS	NON-PUB.1-8	264				2
S394	EVERETT	POPE JOHN HIGH	888 BROADWAY	NON-PUB.9-12	916				2
S395	EVERETT	ST.ANTHONY	54 OAKES	NON-PUB.K-8	263				2
S396	EVERETT	WEBSTER	26 DARTMOUTH	PUB.6	245				2
S397	LEXINGTON	BOWMAN	PHILIP RD.	PUB.K-6	391				3
S398	LEXINGTON	BRIDGE	55 MIDDLEBY	PUB.K-6	411				1
S399	LEXINGTON	FISKE	34A COLONY RD	PUB.K-6	267				2
S400	LEXINGTON	HARRINGTON	146 MAPLE	PUB.K-6	298				1
S401	LEXINGTON	JONAS CLARKE JR HIGH	STEPMAN RD.	PUB.7-9	660				2
S402	LEXINGTON	JOSEPH ESTABROOK	117 GROVE	PUB.K-6	434				1
S403	LEXINGTON	LEXINGTON CHRISTIAN	48 BARTLETT AVE	NON-PUB.7-12	257				1
S404	LEXINGTON	LEXINGTON HIGH	251 WALTHAM	PUB.10-12	1550				2
S405	LEXINGTON	LEXINGTON MONTESSORI	130 PLEASANT	NON-PUB.N-K	116				1
S406	LEXINGTON	LEXINGTON NURSERY &	9 PIPER RD.	NON-PUB.N-K	40				1
S407	LEXINGTON	MARIA HASTINGS	2618 MASS. AVE	PUB.K-6	311				1
S408	LEXINGTON	MINUTE MAN VOC.TECH.	758 MARRETT RD.	REG.SCH. 9-13	0				1
S409	LEXINGTON	THE KREBS SCH.FOUND.	453 CONCORD AVE.	NON-PUB.N-8	40				1
S410	LEXINGTON	WALDORF	739 MASS. AVE	NON-PUB.N-7	188				2
S411	LEXINGTON	WESTBRIDGE	20 PELHAM RD.	NON-PUB.7-12	92				2
S412	LEXINGTON	WM DIAMOND JR HIGH	99 HANCOCK	PUB.7-9	630				2
S413	LYNN	A DREWICZ ELEMENTARY	34 HOOD	PUB.1-6	406	MASONRY	LOW	1940's	2
S414	LYNN	ABORN	409 EASTERN AVE	PUB.K-6	269				1
S415	LYNN	ASTOR	58 BLOSSOM ST.	PUB.8-12	31				2
S416	LYNN	BREED JR HIGH	90 O'CALLAGHAN	PUB.7-8	767				2
S417	LYNN	BRICKETT ELEMENTARY	123 LEWIS	PUB.1-6	363				1
S418	LYNN	BUSY BEE NURSERY &	39 SEVERANCE	NON-PUB.N-K	95				1
S419	LYNN	CAPT.WM G SHOEMAKER	26 REGINA RD	PUB.K-6	202				1
S420	LYNN	CHRIST CHILD NURSERY	37 NORTH FEDERAL	NON-PUB.N-K	244				2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S421	LYNN	CLASSICAL HIGH	33 NORTH COMMON	PUB.10-12	865				2
S422	LYNN	COBBET ELEMENTARY	40 FRANKLIN	PUB.K-6	412	MASONRY	LOW	1921	2
S423	LYNN	COMMUNITY DAY SCHOOL	176 FRANKLIN	PUB.UG	36				2
S424	LYNN	DEVELOPMENTAL SCHOOL	163 JOHNSON	NON.PUB.SP.	9				2
S425	LYNN	E J HARRINGTON	21 DEXTER	PUB.K-6	365				1
S426	LYNN	EASTERN JR HIGH	19 PORTER	PUB.7-8	804				1
S427	LYNN	EDWARD A SISSON	58 CONCORD AVE	PUB.K-6	442				3
S428	LYNN	HEAD START DAY CARE	360 WASHINGTON	NON-PUB.N	169				1
S429	LYNN	HIGHLAND	49 HOLLINGSWORTH	PUB.K-6	451				1
S430	LYNN	HITCHING POST NURSER	20 NEPTUNE BLVD.	NON-PUB.N	15				2
S431	LYNN	HOOD	24 OAKWOOD AVE	PUB.K-6	478				1
S432	LYNN	INGALLS	1 COLLINS TERRACE	PUB.K-6	507				1
S433	LYNN	JULIA F CALLAHAN	165 O'CALLAGHAN WAY	PUB.K-6	400				3
S434	LYNN	KINDERCARE	12 ANCHOR RD.	NON.PUB.N.	67				1
S435	LYNN	LINCOLN	115 GARDINER	PUB.K-6	188				2
S436	LYNN	LITTLE THEATRE NURS.	503 LYNNFIELD	NON-PUB.N-K	113				1
S437	LYNN	LYNN ENGLISH HIGH	50 GOODRIDGE	PUB.9-12	1628	MASONRY	LOW	1930	3
S438	LYNN	LYNN WOOODS	31 TREVETT AVE	PUB.K-6	169				1
S439	LYNN	NORTH SHORE CHRISTIA	26 URBAN	NON-PUB.K-6	158				1
S440	LYNN	PICKERING JR HIGH	70 CONCORD AVE	PUB.7-8	461				3
S441	LYNN	PROJECT CHILDREN	11 WEBSTER	NON-PUB.N-K	77				1
S442	LYNN	SACRED HEART	100 ROBINSON	NON-PUB.1-8	306				2
S443	LYNN	SEWELL-ANDERSON	25 ONTARIO	PUB.K-6	188				1
S444	LYNN	ST.JEAN BAPTISTE	25 ENDICOTT	NON-PUB.1-8	215	MASONRY	LOW		2
S445	LYNN	ST.MARY HIGH	35 TREMONT	NON-PUB.9-12	420				2
S446	LYNN	ST.PIUS V	28 BOWLER	NON-PUB.K-8	575	MASONRY	LOW	1959	3
S447	LYNN	SUNNY DAY	5 TRACY AVE.	NON-PUB.N-K	52				3
S448	LYNN	TRACY	35 WALNUT	PUB.1-6	379				1
S449	LYNN	VOCATIONAL TECH.INST	NEPTUNE BLVD.	PUB.10-12	942				2
S450	LYNN	WASHINGTON COMMUNITY	58 BLOSSOM	PUB.K-6	355				2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S451	LYNN	WM P CONNERY	50 ELM	PUB.K-6	298				2
S452	MALDEN	BEEBE JR HIGH	401 PLEASANT	PUB.7-8	413				3
S453	MALDEN	BELMONT	52 CROSS	PUB.K-6	421				2
S454	MALDEN	BROWNE JR HIGH	289 BROADWAY	PUB.7-8	338				3
S455	MALDEN	CHEVERUS ELEMENTARY	30 IRVING	NON-PUB.1-8	524				3
S456	MALDEN	EMERSON	HIGHLAND AVE	PUB.K-6	275				3
S457	MALDEN	FORESTDALE	SYLVAN	PUB.K-6	275				1
S458	MALDEN	GIRLS CATHOLIC HIGH	366 CHARLES	NON-PUB.9-12	172				3
S459	MALDEN	GLENWOOD	145 GLENWOOD	PUB.K-6	393				1
S460	MALDEN	HOLMES	257 MOUNTAIN AVE	PUB.K-6	427				1
S461	MALDEN	IMMACULATE CONCEPTIO	306 HIGHLAND AVE.	NON-PUB.1-8	492				3
S462	MALDEN	INDEPENDENCE RTE.DAY	333 BRYANT	NON-PUB.N	41				3
S463	MALDEN	LINCOLN ELEMENTARY	333 CROSS	PUB.K-6	459				3
S464	MALDEN	LINCOLN JR HIGH	333 CROSS	PUB.7-8	270				3
S465	MALDEN	LINDEN	WESCOTT	PUB.K-6	356				3
S466	MALDEN	MALDEN CATHOLIC HIGH	99 CRYSTAL	NON-PUB.9-12	807				3
S467	MALDEN	MALDEN HIGH	77 SALEM	PUB.9-12	2127				3
S468	MALDEN	MAPLEWOOD	LAUREL	PUB.K-6	414				3
S469	MALDEN	PROJECT TRIANGLE	239 COMMERCIAL	NON.PUB.SP.	16				3
S470	MARBLEHEAD	DEVEREUX	44 SMITH	NON-PUB.N-5	71				3
S471	MARBLEHEAD	DR SAMUEL C EVELETH	BROOK RD	PUB.K-2	116				1
S472	MARBLEHEAD	ELBRIDGE GERRY	ELM	PUB.K-3	58				1
S473	MARBLEHEAD	GLOVER	9 MAPLE	PUB.K-5	287				2
S474	MARBLEHEAD	L H COFFIN	TURNER RD	PUB.K-5	239				2
S475	MARBLEHEAD	MALCOLM L BELL	40 BALDWIN RD	PUB.K-5	329				3
S476	MARBLEHEAD	MARBLEHEAD HIGH	217 PLEASANT	PUB.9-12	1047				3
S477	MARBLEHEAD	MARBLEHEAD MID SCH	VILLAGE	PUB.6-9	599				1
S478	MARBLEHEAD	TOWER	61 WEST SHORE DR.	NON-PUB.N-9	205				3
S479	MEDFORD	COLUMBUS	37 HICKS AVE	PUB.K-6	166				3
S480	MEDFORD	CURTIS-TUFTS	437 MAIN	PUB.UG	31				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S481	MEDFORD	ELIOT-PEARSON CHILD.	105 COLLEGE AVE.	NON-PUB.N-K	176				3
S482	MEDFORD	FOREST PARK	225 GOVERNOR'S AVE	PUB.K-6	143				1
S483	MEDFORD	FRANKLIN	68 CENTRAL AVE	PUB.K-4	234				3
S484	MEDFORD	GEORGE DAVENPORT	HORNE AVE	PUB.K-6	247				1
S485	MEDFORD	GLEASON	PLAYSTEAD RD	PUB.K-6	216				3
S486	MEDFORD	HOBBS JR HIGH	25 AUBURN	PUB.7-8	543				3
S487	MEDFORD	J.F.KENNEDY ELEMEN.	215 HARVARD	PUB.K-6	593	MASONRY	LOW	1955	3
S488	MEDFORD	LORIN L DAME	80 GEORGE	PUB.K-6	346				3
S489	MEDFORD	MEDFORD HIGH	489 WINTHROP	PUB.9-12	1757	REIN. CONC.	LOW	1970	1
S490	MEDFORD	MILTON FULLER ROBERT	35 COURT	PUB.4-8	397	MASONRY	LOW	1956	3
S491	MEDFORD	OSGOOD	101 FOURTH	PUB.K-6	257				3
S492	MEDFORD	ST. CLEMENT HIGH	579 BOSTON AVE.	NON.PUB.9-12	336	MASONRY	LOW	1941	3
S493	MEDFORD	ST.CLEMENTS GRAMMAR	589 BOSTON AVE.	NON-PUB.K-8	427	MASONRY	LOW	1941	3
S494	MEDFORD	ST.FRANCIS OF ASSISI	1 ST.CLARE RD.	NON-PUB.1-8	463	MASONRY	LOW	1956	3
S495	MEDFORD	ST.JOSEPH	132 HIGH	NON-PUB.1-8	363	MASONRY	LOW	1963	3
S496	MEDFORD	ST.RAPHAEL	516 HIGH	NON-PUB.1-8	294	MASONRY	LOW	1961	3
S497	MEDFORD	SWAN ELEMENTARY	75 PARK	PUB.K-6	336				3
S498	MEDFORD	TUFTS DAY CARE	TUFTS UNIVERSITY	PUB.N-K	0				1
S499	MEDFORD	TUFTS UNIVERSITY	PACKARD AVE.	4YR.COLLEGE	0				1
S500	MELROSE	DECIUS BEEBE	263 WEST FOSTER	PUB.K-6	330				2
S501	MELROSE	FRANKLIN	16 FRANKLIN	PUB.K-6	272				2
S502	MELROSE	HERBERT CLARK HOOVER	GLENDOWER RD	PUB.K-6	180				1
S503	MELROSE	HORACE MANN	DAMON AVE	PUB.K-6	227				1
S504	MELROSE	LINCOLN	80 W.WYOMING AVE	PUB.K-6	361				3
S505	MELROSE	MELROSE HIGH	360 LYNN FELLS PKWY	PUB.10-12	1171				2
S506	MELROSE	MELROSE JR HIGH	350 LYNN FELLS PKWY	PUB.7-9	1113				2
S507	MELROSE	MELROSE MONTESSORI	70 W EMERSON	NON-PUB.N-K	45				2
S508	MELROSE	MELROSE NUR,KIN DAY	15 BARTLETT	NON-PUB.N-K	92				1
S509	MELROSE	RIPLEY	94 LEBANON	PUB.K-6	128				1
S510	MELROSE	ROOSEVELT	253 VINTON	PUB.K-6	222				2

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S511	MELROSE	ST.MARY ANNUNCIATION	4 MYRTLE	NON-PUB.K-8	357				3
S512	MELROSE	WINTHROP	162 FIRST	PUB.K-5	347				1
S513	MILTON	AQUINAS JR. COLLEGE	303 ADAMS ST.	2YR.ASSOC.DEG.	0				1
S514	MILTON	CHARLES S PIERCE JR	GILE RD	PUB.6-8	655				1
S515	MILTON	COLLICUT	75 EDGE HILL RD	PUB.K-5	360				1
S516	MILTON	CURRY COLLEGE	1071 BLUE HILL AVE.	4YR.COLLEGE	0				2
S517	MILTON	FONTBONNE ACADEMY	930 BROOK RD.	NON-PUB.9-12	574				1
S518	MILTON	GLOVER	255 CANTON AVE	PUB.K-5	340				3
S519	MILTON	MILTON ACADEMY	170 CENTRE	NON-PUB.K-12	903				1
S520	MILTON	MILTON HIGH	BROOK RD AT CENTRAL	PUB.9-12	994				1
S521	MILTON	SHALOM HOUSE DAY	68 SMITH RD	NON-PUB.N-7	107				1
S522	MILTON	ST.AGATHA	440 ADAMS	NON-PUB.1-8	448				1
S523	MILTON	ST.MARY OF THE HILLS	250 BROOK RD.	NON-PUB.1-8	404				3
S524	MILTON	THACHER MONTESSORI	44 EDGE HILL RD.	NON-PUB.N-6	139				1
S525	MILTON	THE CARRIAGE HOUSE S	535 CANTON AVE	NON.PUB.	11				3
S526	MILTON	TUCKER	187 BLUE HILL PKWY	PUB.K-5	445				3
S527	NAHANT	JOHNSON	CASTLE RD	PUB.K-8	220				3
S528	NEWTON	A E ANGIER	1697 BEACON	PUB.K-6	413	MASONRY	LOW	1952	2
S529	NEWTON	AQUINAS JR COLLEGE	115 WALNUT PARK	2YR.ASSOC.DEG.	0				2
S530	NEWTON	BC CAMPUS DAY SCHOOL	ROBERT CENTER RM 213	NON.PUB.SP.	57				2
S531	NEWTON	BIGELOW JR HIGH	42 VERNON	PUB.7-8	350				2
S532	NEWTON	BOWEN	280 CYPRESS	PUB.K-6	312				1
S533	NEWTON	BRIMMER & MAY	60 MIDDLESEX RD.	NON-PUB.1-12	196				1
S534	NEWTON	CABOT	229 CABOT	PUB.K-6	336				3
S535	NEWTON	CC BURR	171 PINE	PUB.K-6	204				2
S536	NEWTON	CHARLES E. BROWN JR.	125 MEADOWBROOK RD.	PUB.7-8	600				1
S537	NEWTON	CHESTNUT HILL	428 HAMMOND	NON-PUB.K-6	131				1
S538	NEWTON	CLEARWAY SCHOOL	61 CHESTNUT ST.	NON-PUB.SP.	21				1
S539	NEWTON	COMM.CTR. FOR CHILDR	147 PRINCE	NON-PUB.SP.	42				1
S540	NEWTON	COUNTRYSIDE	191 DEDHAM	PUB.K-6	379				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S541	NEWTON	EDCO	360 LOWELL AVE.	NON-PUB.SP.	44				2
S542	NEWTON	FA DAY JR HIGH	21 MINOT PL	PUB.7-8	604				3
S543	NEWTON	FESSENDEN	250 WALTHAM	NON-PUB.1-9	353				2
S544	NEWTON	FRANKLIN	125 DERBY	PUB.K-6	345				2
S545	NEWTON	HORACE MANN	687 WATERTOWN	PUB.K-6	268				3
S546	NEWTON	JACKSON SCHOOL	200 JACKSON RD.	NON-PUB.1-6	169				2
S547	NEWTON	JOHN WARD	10 DOLPHIN RD	PUB.K-6	286				1
S548	NEWTON	LASELL JR.COLLEGE	1844 COMMONWEALTH AV	2YR.ASSOC.DEG.	0				2
S549	NEWTON	LEAGUE SCHOOL	225 NEVADA	NON.PUB.SP.	71				2
S550	NEWTON	LINCOLN-ELIOT	191 PEARL	PUB.K-6	246				2
S551	NEWTON	LITTLE PEOPLE'S SCH.	1507 WASHINGTON	NON-PUB.SP.	205				2
S552	NEWTON	MASON-RICE	149 PLEASANT	PUB.K-6	418				2
S553	NEWTON	MASS.SCH.PROF.PSYCH.	785 CENTER ST.	4YR.COLLEGE	0				1
S554	NEWTON	MEMORIAL SPAULDING	250 BROOKLINE	PUB.K-6	372				1
S555	NEWTON	MT.ALVERINA ELEM.	20 MANET RD.	NON-PUB.K-8	217				1
S556	NEWTON	MT.ALVERINA HIGH	790 CENTRE	NON-PUB.9-12	174				1
S556a	NEWTON	MT. IDA COLLEGE	777 DEDHAM ST.	2YR.COLLEGE	0				1
S557	NEWTON	NEWTON CATHOLIC ELEM	25 LENGLEN RD.	NON-PUB.1-8	311				3
S558	NEWTON	NEWTON CATHOLIC HIGH	575 WASHINGTON	NON-PUB.9-12	220	MASONRY	LOW		1
S559	NEWTON	NEWTON NORTH HIGH	360 LOWELL RD	PUB.9-12	2540	MASONRY	LOW	1970	2
S560	NEWTON	NEWTON SOUTH HIGH	140 BRANDEIS RD	PUB.9-12	1298	MASONRY	LOW	1959	1
S561	NEWTON	PIERCE	170 TEMPLE	PUB.K-6	291				2
S562	NEWTON	SACRED HEART COUNTRY	785 CENTRE	NON-PUB.7-12	234	MASONRY	LOW	1920	1
S563	NEWTON	SOLOMON SCHECHTER DA	60 STEIN CIRCLE	NON-PUB.K-8	365				1
S564	NEWTON	UNDERWOOD	101 VERNON	PUB.K-6	291				2
S565	NEWTON	WALNUT PK MONTESSORI	47 WALNUT PK.	NON-PUB.N-K	126				2
S566	NEWTON	WILLIAMS	141 GROVE	PUB.K-6	223				2
S567	NEWTON	ZERVAS	30 BEETHOVEN	PUB.K-6	278				2
S568	QUINCY	AMEGO	10 MERRYMOUNT RD.	NON-PUB.SP.	21				3
S569	QUINCY	ATHERTON HOUGH	1084 SEA	PUB.K-5	314				3
S570	QUINCY	ATLANTIC MIDDLE	86 HOLLIS AVE	PUB.6-8	540				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S571	QUINCY	BROAD MEADOWS MIDDLE	50 CALVIN	PUB.6-8	381				3
S572	QUINCY	CENTRAL MIDDLE	1012 HANCOCK	PUB.6-8	592				3
S573	QUINCY	DANIEL WESTER	LANCASTER	PUB.K-5	396	MASONRY	LOW	1916	3
S574	QUINCY	FRANCIS W PARKER	148 BILLINGS RD	PUB.K-5	507	MASONRY	LOW	1916	3
S575	QUINCY	FURNACE BROOK	701 FURNACE BROOK	PUB.K-5	383	MASONRY	LOW	1954	3
S576	QUINCY	LINCOLN-HANCOCK	300 GRANITE	PUB.K-5	491	MASONRY	LOW	1972	1
S577	QUINCY	MASS CP-SOUTH SHORE	105 ADAMS STREET	NON.PUB.SP.	24				3
S578	QUINCY	MERRYMOUNT	4 AGAWAM RD	PUB.K-5	297				3
S579	QUINCY	MONTCLAIR	8 BELMONT	PUB.1-5	406				3
S580	QUINCY	NORTH QUINCY HIGH	316 HANCOCK	PUB.9-12	1592	MASONRY	LOW	1925	3
S581	QUINCY	QUINCY HIGH	52 CODDINGTON	PUB.9-12	1326	MASONRY	LOW	1977	3
S582	QUINCY	QUINCY JR.COLLEGE	34 CODDINGTON ST.	MUNICIPAL JR.C.	0				3
S583	QUINCY	QUINCY POINT MIDDLE	EDWARDS	PUB.6-8	221				3
S584	QUINCY	QUINCY VOC.TECH	WOODWARD AVE	PUB.9-12	625				3
S585	QUINCY	REAY E STERLING JR H	444 GRANITE	PUB.6-8	279				1
S586	QUINCY	SACRED HEART	346 HANCOCK	NON-PUB.1-8	461	MASONRY	LOW	1930	3
S587	QUINCY	SAINT MARY	121 CRESCENT	NON-PUB.1-8	225	MASONRY	LOW	1927	1
S588	QUINCY	SNUG HARBOR	333 PALMER	PUB.K-5	483				3
S589	QUINCY	SQUANTUM	50 HUCKINS AVE	PUB.K-5	299				1
S590	QUINCY	ST.ANN	1 ST.ANN RD.	NON-PUB.SP.	202				3
S591	QUINCY	ST.JOSEPH	22 PRAY	NON-PUB.1-8	243	MASONRY	LOW	1986	3
S592	QUINCY	WOODWARD SCHOOL FOR	1102 HANCOCK	NON-PUB.6-12	147				3
S593	REVERE	ABRAHAM LINCOLN	68 TUCKERMAN	PUB.K-8	592				2
S594	REVERE	AUGUSTINE C WHEELAN	107 NEWHALL	PUB.K-7	740				2
S595	REVERE	BEACHMONT	15 EVERARD	PUB.K-8	652				3
S596	REVERE	IMMACULATE CONCEPTIO	127 WINTHROP AVE.	NON-PUB.N-8	288				3
S597	REVERE	JAMES A GARFIELD	168 GARFIELD AVE	PUB.K-6	468				3
S598	REVERE	PAUL REVERE	395 REVERE	PUB.K-8	430				3
S599	REVERE	REVERE HIGH	101 SCHOOL	PUB.9-12	1624				3
S600	REVERE	WILLIAM MCKINLEY	65 YEAMAN	PUB.K-8	322				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S601	SALEM	BATES	LIBERTY HILL AVE	PUB.K-5	306				1
S602	SALEM	BENTLEY	MEMORIAL DR	PUB.K-5	254				3
S603	SALEM	CARLTON	10 SKERRY	PUB.K-5	172				3
S604	SALEM	HORACE MANN LABORATO	19 LORING AVE	PUB.K-5	522				3
S605	SALEM	HOUSE OF 7 GABLES PR	114 DERBY	NON.PUB.N	35				3
S606	SALEM	KIDDIE KOOP INC.	98 NORTH	NON.PUB.N-K	16				3
S607	SALEM	KINDER CARE LEARN CT	572 LORING AVE.	NON.PUB.N-K	14				2
S608	SALEM	MIDDLE SCHOOL EAST	211 LAFAYETTE	PUB.6-8	287				3
S609	SALEM	MIDDLE SCHOOL WEST	29 HIGHLAND AVE.	PUB.6-8	670				3
S610	SALEM	PHOENIX	20 CENTRAL	NON.PUB.K-8	66				3
S611	SALEM	SALEM HIGH	77 WILLSON	PUB.9-12	1421				1
S612	SALEM	SALEM MONTESORRI	4 HOLLY	NON.PUB.N-K	17				1
S613	SALEM	SALEM STATE COLLEGE	352 LAFAYETTE ST.	STATE COLLEGE	0				1
S614	SALEM	ST.JOSEPH	20 HARBOR	NON-PUB.K-8	264				3
S615	SALEM	THE GREENHOUSE SCHOO	145 LORING AVE.	NON.PUB.UG	51				3
S616	SALEM	WITCHCRAFT HEIGHTS	1 FREDERICK	PUB.K-5	510				1
S617	SALEM	YOUNG WORLD NURSEY	5 GREENLEDGE	NON.PUB.N-K	65				1
S618	SAUGUS	BALLARD	RICHARD	PUB.1-4	138				1
S619	SAUGUS	BELMONTE JR. HIGH	DOW	PUB.7-9	961				1
S620	SAUGUS	DOUGLAS WAYBRIGHT	TALBOT	PUB.K-6	254				1
S621	SAUGUS	EVANS	EAST DENVER	PUB.K-6	246				1
S622	SAUGUS	LYNNHURST	ELM	PUB.K-6	342				1
S623	SAUGUS	OAKLANDVALE	266 MAIN	PUB.K-6	267				1
S624	SAUGUS	SAUGUS HIGH	PEARCE DR	PUB.10-12	951				3
S625	SAUGUS	VETERANS MEMORIAL	HURD AVE	PUB.K-6	601				3
S626	SOMERVILLE	ARTHUR D HEALEY	5 MEACHAM	PUB.K-6	428				2
S627	SOMERVILLE	BENJAMIN G BROWN	201 WILLOW AVE	PUB.K-6	217				3
S628	SOMERVILLE	CUMMINGS	93 SCHOOL	PUB.K-6	247				2
S629	SOMERVILLE	E SOMERVILLE COMMUN	115 PEARL	PUB.K-8	828				3
S630	SOMERVILLE	FULL CIRCLE	165 BROADWAY	NON-PUB.9-12	59				3

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S631	SOMERVILLE	J.F. KENNEDY	85 ELM	PUB.K-8	425				2
S632	SOMERVILLE	LINCOLN PARK COMMUN.	290 WASHINGTON	PUB.K-8	787				3
S633	SOMERVILLE	LITTLE FLOWER	17 FRANKLIN	NON-PUB.K-8	222				3
S634	SOMERVILLE	NEXT WAVE	156 HIGHLAND AVE.	NON.PUB.7-9	29				2
S635	SOMERVILLE	POWDER HOUSE COMMUN.	1060 BROADWAY	PUB.K-8	661				2
S636	SOMERVILLE	S NEWTON CUTLER	177 POWDER HOUSE BLV	PUB.K-6	266				2
S637	SOMERVILLE	SOMERVILLE HIGH	81 HIGHLAND	PUB.9-12	2642				2
S638	SOMERVILLE	ST.ANN	50 THURSTON	NON-PUB.K-8	268				2
S639	SOMERVILLE	ST.ANTHONY	480 SOMERVILLE AVE.	NON-PUB.K-8	198				3
S640	SOMERVILLE	ST.CATHERINE OF GEND	194 SUMMER	NON-PUB.K-8	358				2
S641	SOMERVILLE	ST.JOSEPH	15 WEBSTER AVE.	NON-PUB.K-8	230				3
S642	SOMERVILLE	ST.POLYCARP	8 BUTLER DR.	NON-PUB.1-8	217				3
S643	SOMERVILLE	WINTER HILL COMMUN	115 SYCAMORE	PUB.K-8	703				2
S644	STONEHAM	CENTRAL	25 WILLIAM	PUB.1-6	462				1
S645	STONEHAM	COLONIAL PARK	AVALON RD	PUB.K-5	159				1
S646	STONEHAM	EDGEWOOD	108 POND ST.	NON-PUB.1-8	0				1
S647	STONEHAM	GREATER BOSTON ACADE	20 WOODLAND RD.	NON-PUB.9-12	81				1
S648	STONEHAM	LESLIE COUNTRY DAY	27 HIGH	NON-PUB.N-K	71				1
S649	STONEHAM	NORTH	COLINCOTE	PUB.K-6	179				1
S650	STONEHAM	PURPOSE	MAIN @ CHURCH	NON-PUB.K	124				1
S651	STONEHAM	ROBIN HOOD	MAGNOLIA TERRACE	PUB.K-6	357				1
S652	STONEHAM	SOUTH	SUMMER	PUB.K-4	199				1
S653	STONEHAM	ST.PATRICK	20 PLEASANT	NON-PUB.1-8	274				1
S654	STONEHAM	STONEHAM HIGH	149 FRANKLIN	PUB.9-12	1035				1
S655	STONEHAM	STONEHAM JR HIGH	101 CENTRAL	PUB.7-8	478				1
S656	SWAMPSCOTT	CLARKE	NORFOLK AVE	PUB.K-6	167				1
S657	SWAMPSCOTT	HADLEY	24 REDINGTON	PUB.K-6	326				1
S658	SWAMPSCOTT	HILLEL ACADEMY	837 HUMPHREY	NON-PUB.K-9	165				1
S659	SWAMPSCOTT	MACHON	35 BURPEE RD	PUB.K-6	153				1
S660	SWAMPSCOTT	MARIAN CT.JR.COLLEGE	35 LITTLE'S POINT RD	2YR.ASSOC.DEG.	0				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S661	SWAMPSCOTT	STANLEY	WHITMAN RD	PUB.K-6	277				1
S662	SWAMPSCOTT	SWAMPSCOTT HIGH	1 FOREST AVE	PUB.9-12	887				1
S663	SWAMPSCOTT	SWAMPSCOTT JR HIGH	71 GREENWOOD AVE	PUB.7-8	412				1
S664	WAKEFIELD	ACADEMY OF OUR LADY	14 WINSHIP DR.	NON-PUB.9-12	263				1
S665	WAKEFIELD	ATWELL	485 MAIN	PUB.6	248				1
S666	WAKEFIELD	DOLBEARE	340 LOWELL	PUB.1-5	149				2
S667	WAKEFIELD	DOYLE	11 PAUL AVE	PUB.K-5	145				1
S668	WAKEFIELD	E. MIDDLESEX ALT HS	273 VERNON	NON.PUB.SP.	0				2
S669	WAKEFIELD	FRANKLIN	100 NAHANT	PUB.K-5	246				1
S670	WAKEFIELD	GREENWOOD	1030 MAIN	PUB.K-5	309				1
S671	WAKEFIELD	HURD	26 CORDIS	PUB.K-5	133				1
S672	WAKEFIELD	MONTROSE	531 LOWELL	PUB.K-5	245				1
S673	WAKEFIELD	N.E.METRO.VOC.SCH.	HEMLOCK RD.	REG.SCH. 9-14	0				1
S674	WAKEFIELD	ST.JOSEPH	15 GOULD	NON-PUB.K-8	271				2
S675	WAKEFIELD	WAKEFIELD JR HIGH	525 MAIN	PUB.7-8	640				1
S676	WAKEFIELD	WAKEFIELD MEM.HIGH	60 FARM	PUB.9-12	1234				3
S677	WAKEFIELD	WALTON	40 WESTERN	PUB.1-5	182				1
S678	WAKEFIELD	WEST WARD	39 PROSPECT	PUB.K-1	64				1
S679	WALTHAM	BENTLEY COLLEGE	BEAVER @ FOREST	4YR.COLLEGE	0				1
S680	WALTHAM	BRANDEIS UNIVERSITY	415 SOUTH ST.	4YR.COLLEGE	0				1
S681	WALTHAM	CENTRAL MIDDLE	55 SCHOOL	PUB.6-8	619				1
S682	WALTHAM	CHAPEL HILL CHAUNCY	327 LEXINGTON	NON-PUB.9-13	172				1
S683	WALTHAM	DOUGLAS MACARTHUR	494 LINCOLN	PUB.K-6	392				1
S684	WALTHAM	EZRA C FITCH	14 ASH	PUB.K-5	279				2
S685	WALTHAM	GAEBLER	258 TRAPELO RD.	STATE SCH.UG-10	0				1
S686	WALTHAM	GREEN ACRES DAY	439 LEXINGTON	NON-PUB.N-K	103				1
S687	WALTHAM	HENRY WHITTEMORE	30 PARMENTOR RD	PUB.K-5	358				2
S688	WALTHAM	J.F.KENNEDY JR HIGH	655 LEXINGTON	PUB.6-8	463				1
S689	WALTHAM	JAMES FITZGERALD ELE	140 BEAL RD	PUB.K-5	224				1
S690	WALTHAM	JONATHAN BRIGHT	260 GROVE	PUB.K-5	138				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S691	WALTHAM	NATHANIEL P BANKS	948 MAIN	PUB.K-5	281				1
S692	WALTHAM	NORTHEAST	PUTNEY LN	PUB.K-5	349				1
S693	WALTHAM	OUR LADY COMFORTER	920 TRAPELO RD.	NON-PUB.K-8	246				1
S694	WALTHAM	SOUTH MIDDLE	520 MOODY	PUB.6-8	387				2
S695	WALTHAM	ST.JUDE	175 MAIN	NON-PUB.K-7	203				1
S696	WALTHAM	THOMAS K PLYMPTON	20 FARNSWORTH	PUB.K-5	422				3
S697	WALTHAM	WALTHAM SR HIGH	617 LEXINGTON	PUB.9-12	2019				1
S698	WALTHAM	WALTHAM VOC.HIGH	100 SUMMER	PUB.9-13	310				1
S699	WATERTOWN	AGBU ARMENIAN ELEM.	465 MT. AUBURN	NON-PUB.N-6	107				3
S700	WATERTOWN	ATRIOM	47 NICHOLS AVE.	NON.PUB.N-2	0				3
S701	WATERTOWN	BROWNE	552 MAIN	PUB.K-6	170				2
S702	WATERTOWN	COOLIDGE	319 ARLINGTON	PUB.K-6	162				3
S703	WATERTOWN	CUNNIFF	246 WARREN	PUB.K-6	183				2
S704	WATERTOWN	FERNALD STATE SCHOOL	340 MT AUBURN	STATE SCH.UG	35				3
S705	WATERTOWN	HOSMER/EAST	CONCORD RD	PUB.K-8	605				2
S706	WATERTOWN	JAMES RUSSELL LOWELL	ORCHARD	PUB.K-6	269				1
S707	WATERTOWN	MARSHALL/WEST	WAVERLEY AVE	PUB.K-8	398				1
S708	WATERTOWN	N E HOPE-ORCHARD	917 BELMONT	NON-PUB.SP.	7				1
S709	WATERTOWN	PALFREY STREET	119 PALFREY	NON-PUB.9-12	38				2
S710	WATERTOWN	PERKINS SCH.FOR BLIN	175 NORTH BEACON	NON-PUB.UG.	201				1
S711	WATERTOWN	PHILLIPS	30 COMMON	PUB.K;6	213				3
S712	WATERTOWN	RUSARY ACADEMY	130 LEXINGTON	NON-PUB.K-8	153				2
S713	WATERTOWN	ST.PATRICK ELEM.	20 CHURCH HILL	NON-PUB.N-8	246				3
S714	WATERTOWN	ST.PATRICK HIGH	26 CHESTNUT	NON-PUB.9-12	172				3
S715	WATERTOWN	WATERTOWN HIGH	51 COLUMBIA	PUB.9-12	1111				2
S716	WINCHESTER	AGAPE CHRISTIAN ACAD	263 MAIN	NON.PUB.K-4	66				1
S717	WINCHESTER	AMBROSE ELEMENTARY	27 HIGH	PUB.K-6	252				1
S718	WINCHESTER	BARTLETT SCHOOL	40 SAMOSET RD.	NON-PUB.K-7	147				1
S719	WINCHESTER	CHILDREN'S OWN SCH.	86 MAIN	NON-PUB.N-1	80				1
S720	WINCHESTER	LINCOLN	161 MYSTIC VALLEY PK	PUB.K-6	394				1

TABLE 3.12a (cont.)
SCHOOLS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	TOTAL STUDENTS	STRUCTURE CLASSIFICATION	STRUCTURE HEIGHT	YEAR BUILT	SEISMIC HAZARD
S721	WINCHESTER	LYNCH ELEM.	10 BRANTWOOD RD	PUB.K-6	267				3
S722	WINCHESTER	MCCALL JR HIGH	458 MAIN	PUB.7-8	516				3
S723	WINCHESTER	MURACO	61 IRVING	PUB.K-6	259				3
S724	WINCHESTER	ST.MARY	162 WASHINGTON	NON-PUB.N-8	219				1
S725	WINCHESTER	VINSON-OWEN	75 JOHNSON RD	PUB.K-6	243				1
S726	WINCHESTER	WINCHESTER HIGH	80 SKILLINGS RD.	PUB.9-12	1217				3
S727	WINTHROP	ARTHUR W DALRYMPLE	GROVERS AVE	PUB.K-5	316				1
S728	WINTHROP	N ELLIOT WILLIS	HERMON	PUB.K-5	451				2
S729	WINTHROP	ST.JOHN THE EVANGELI	LINCOLN	NON-PUB.K-8	252				2
S730	WINTHROP	WINTHROP MIDDLE	PAULINE	PUB.6-8	536				2
S731	WINTHROP	WINTHROP SR HIGH	MAIN	PUB.9-12	853				3
S732	WOBURN	CHILDREN'S CTR.	533 MAIN	NON-PUB.N	71				2
S733	WOBURN	CLYDE REEVES	LEXINGTON	PUB.K-6	346				1
S734	WOBURN	DANIEL P HURLD	BEDFORD RD	PUB.K-6	253				2
S735	WOBURN	GATEWAY TO LEARNING	736 MAIN	NON.PUB.N-K	105				2
S736	WOBURN	GEORGE I CLAPP	HUDSON @ ARLINGTON	PUB.K-6	199				1
S737	WOBURN	GOODYEAR	ORANGE	PUB.K-6	277				2
S738	WOBURN	J.F.KENNEDY JR HIGH	MIDDLE	PUB.7-9	619				2
S739	WOBURN	LINSCOTT-RUMFORD	ELM	PUB.K-6	142				1
S740	WOBURN	MALCOLM WHITE	BOW	PUB.K-6	252				2
S741	WOBURN	MARY A ALTAVESTA	990 MAIN	PUB.K-6	302				2
S742	WOBURN	SHAMROCK MEMORIAL	EASTERN AVE	PUB.K-6	302				2
S743	WOBURN	ST.CHARLES	8 MYRTLE	NON-PUB.K-8	478				1
S744	WOBURN	TARKY	RUSSELL	PUB.K-6	0				1
S745	WOBURN	WOBURN HIGH	88 MONTVALE AVE	PUB.10-12	0				2
S746	WOBURN	WYMAN	MAIN @ EATON AVE	PUB.K-6	344				2

KEY

TYPE OF FACILITY
N = NURSERY
K = KINDERGARDEN
UG = UNGRADED
SP = SPECIAL SCHOOL

TABLE 3.12b

SCHOOLS

STUDENT POPULATION

CITY	PUBLIC K-12	PRIVATE K-12	COLLEGE AND UNIVERSITY
1 ARLINGTON	6,631	1,515	3,830
2 BEDFORD	2,845	57	886
3 BELMONT	4,171	419	1,904
4 BOSTON	69,509	26,685	73,040
5 BROOKLINE	6,030	1,058	7,714
6 CAMBRIDGE	8,822	2,399	23,403
7 CHELSEA	4,164	786	867
8 DEDHAM	4,817	724	1,587
9 EVERETT	5,959	758	1,645
10 LEXINGTON	6,437	400	1,868
11 LYNN	13,904	1,450	3,108
12 MALDEN	8,741	1,130	2,704
13 MARBLEHEAD	3,317	565	1,112
14 MEDFORD	8,786	1,854	4,880
15 MELROSE	5,721	578	1,718
16 MILTON	3,701	1,552	2,243
17 NAHANT	676	-	258
18 NEWTON	12,370	2,168	10,730
19 QUINCY	12,536	2,155	5,633
20 REVERE	6,971	577	1,939
21 SALEM	5,713	796	2,989
22 SAUGUS	5,060	,201	1,205
23 SOMERVILLE	10,047	2,684	7,711
24 STONEHAM	4,022	324	1,304
25 SWAMPSCOTT	2,541	138	915
26 WAKEFIELD	4,530	327	1,320
27 WALTHAM	8,290	850	7,316
28 WATERTOWN	4,386	832	2,668
29 WINCHESTER	4,078	521	1,214
30 WINTHROP	3,007	413	1,106
31 WOBURN	7,053	462	1,868
TOTALS	254,835	54,378	180,685

TABLE 3.12c
SCHOOL BUILDINGS
ENGINEERING STRUCTURE CLASSIFICATION

FACILITY	# SAMPLED	ENGINEERING STRUCTURE CLASSIFICATION											
		1	2	3	4	5	6	7	8	9	10	11	12
PUBLIC SCHOOLS K-12	20			90%	5%		5%						
PRIVATE SCHOOLS K-12	20			100%									
COLLEGES AND UNIVERSITIES	6	15%		42%	24%		8%	5%	6%				

TABLE 3.12d
SCHOOLS
REPLACEMENT VALUES ($-THOUSANDS)
BY CELLS AND ZONES

FACILITY	CELLS / ZONES	1	2	3	4	5	6	7	8	9
PRIVATE SCHOOLS K-12	1	6,945	8,288	6,825	16,635	-	17,460	15,953	41,010	63,548
	2	9,173	3,870	1,320	12,278	28,815	21,360	11,415	3,098	1,500
	3	10,013	2,678	-	28,830	45,720	8,153	50,520	-	38,430
PUBLIC SCHOOLS K-12	1	71,588	60,248	33,443	70,763	13,508	35,145	52,853	84,810	163,020
	2	36,195	24,428	33,825	23,580	133,035	89,535	19,133	8,520	1,725
	3	48,240	23,603	16,943	51,480	133,178	16,583	136,590	-	96,728
COLLEGES & UNIVERSITIES	1	273,280	92,400	192,780	337,960	341,600	590,240	329,840	269,990	78,470
	2	-	-	-	-	-	822,360	164,920	-	78,470
	3	-	-	-	819,070	204,750	186,760	4,677,610	-	724,080

3.13 Special Facilities

3.13.1 Overview.

Dams: The Boston area has many dams used for a variety of purposes such as flood control, water supply, navigation, and recreation. The majority of these dams range in height from 10 to 30 feet and are gravity dams constructed of rock or earth. They range in capacity from 50 acre-feet for the typical small recreational dams to 8,000 acre-feet for the Charles River Dam in Boston. Other dams with large capacities include the Breeds Pond Outlet Dam (5,700 acre-feet) and the Walden Pond East Side Dam (4,000 acre-feet), both in Lynn, and the Cambridge Reservoir Dam (4,800 acre-feet) and Moody Street Dam (3,000 acre-feet), both in Waltham.

The majority of these dams were constructed before World War I, with a minimum constructed after World War II. They are owned and operated by the Massachusetts Water Resource Authority or the municipalities they serve, and their total capacity is approximately 57,000 acre-feet or 325 million gallons of water. Table 3.13a inventories the dams in the study area.

Tall Buildings: A tall building is defined as a building with either 20 or more stories or a height of over 325 feet.

A total of 38 tall buildings were identified in the study area. Nearly all of these are located in downtown Boston, with a few in Cambridge and Arlington. These structures are primarily office buildings although a few are residential. Most of the buildings were constructed after 1970 of steel or mixed steel and concrete. John Hancock Tower, a familiar silhouette in the Boston skyline, is the tallest. Table 3.13b inventories the tall buildings.

3.13.2 Engineering Classifications and Replacement Values. Replacement values for dams are detailed by engineering structure classifi-

cation, cells, and seismic hazard zones in Table 3.13c. Replacement values for tall buildings are detailed by engineering classification structure, cells, and seismic hazard zones in Table 3.13d.

TABLE 3.13a
SPECIAL FACILITIES
DAMS

CODE	CITY	FACILITY NAME	OPERATOR OF FACILITY	TYPE OF FACILITY	RESERVOIR CAPACITY	YEAR BUILT	SEISMIC HAZARD
D 1	ARLINGTON	ARLINGTON RESERVOIR DAM	INCORPORATED	DAM/GRAVITY-GRAVITY	480AF	1900	1
D 2	ARLINGTON	UPPER MYSTIC LAKE DAM	M.W.R.A.	DAM/GRAVITY-OTHER	810AF	1900	3
D 3	BELMONT	PAYSON PARK	CITY OF CAMBRIDGE	DAM/ROCKFILL-OTHER	166AF	1877	2
D 4	BOSTON	CHARLES RIVER DAM, NEW	M.W.R.A	NEW DAM			3
D 5	BOSTON	CHARLES RIVER DAM, OLD	M.W.R.A.	DAM/EARTH-GRAVITY	7976AF	1904	3
D 6	BOSTON	CHESTNUT HILL RES.DAM		RESERVOIR	1270AF	1890	3
D 7	BOSTON	NEPONSET RIVER DAM	M.W.R.A.	RIVER DAM			3
D 8	LEXINGTON	LEXINGTON RESERVOIR DAM	TOWN OF LEXINGTON	RESERVOIR/DAM			1
D 9	LYNN	BREEDS POND OUTLET DAM	CITY OF LYNN	DAM/EARTH-GRAVITY	5730AF	1914	1
D10	LYNN	LYNN RESERVOIR DAM	CITY OF LYNN	DAM	73AF		1
D11	LYNN	SLUICE POND DAM	CITY OF LYNN	DAM/EARTH-ROCKFILL	322AF	1900	3
D12	LYNN	WALDEN POND EAST END DAM	CITY OF LYNN	DAM/EARTH-GRAVITY	4025AF	1893	3
D13	MEDFORD	CRADDOCK DAM	M.W.R.A.	DAM			3
D14	MEDFORD	SOUTH RESERVOIR DAM	TOWN OF WINCHESTER	DAM/ROCKFILL-OTHER	2720F	1900	2
D15	MEDFORD	SOUTH RESERVOIR EAST DIKE	TOWN OF WINCHESTER	EAST DIKE	2720AF		1
D16	MEDFORD	SOUTH RESERVOIR WEST DIKE	TOWN OF WINCHESTER	WEST DIKE	2720AF		1
D17	MEDFORD	WRIGHT'S POND DAM	CITY OF MEDFORD	DAM	334AF		1
D18	MELROSE	FELLS RESERVOIR N.DIKE	M.W.R.A.	RESERVOIR/NORTH DIKE			1
D19	MILTON	NEPONSET LOWER MILLS DAM	M.W.R.A.	RIVER DAM			3
D20	MILTON	PINE TREE BROOK DAM		DAM/GRAVITY-OTHER	90AF	1965	3
D21	MILTON	PINE TREE BROOK RES.DAM		DAM/GRAVITY-OTHER	340AF	1905	3
D22	NEWTON	CORDINGLY DAM	M.W.R.A.	DAM			3
D23	NEWTON	NEWTON LOWER FALLS DAM	M.W.R.A.	DAM/GRAVITY-EARTH	250AF	1900	3
D24	NEWTON	NEWTON UPPER FALLS DAM	M.W.R.A.	DAM/GRAVITY-OTHER	175AF	1912	1
D25	NEWTON	WABAN HILL RES.	M.W.R.A.	RESERVOIR	58AF		1
D26	QUINCY	BLUE HILL RESERVOIR DAM		RESERVOIR	407AF		1
D27	SAUGUS	BIRCH POND DAM	CITY OF LYNN	DAM/EARTH-GRAVITY	1100AF	1872	1
D28	SAUGUS	GRISWOLD POND DAM	TOWN OF SAUGUS	DAM/EARTH-GRAVITY	54AF	1900	1
D29	SAUGUS	HAWKE'S POND OUTLET DAM	CITY OF LYNN	DAM/EARTH-GRAVITY	1080AF	1920	3
D30	SAUGUS	J.A.PEARCE LAKE DAM	M.W.R.A.	DAM/EARTH-GRAVITY	65AF	1900	1

TABLE 3.13a (cont.)
SPECIAL FACILITIES
DAMS

CODE	CITY	FACILITY NAME	OPERATOR OF FACILITY	TYPE OF FACILITY	RESERVOIR CAPACITY	YEAR BUILT	SEISMIC HAZARD
D31	SAUGUS	J.L.SILVER LAKE DAM	M.W.R.A.	DAM/ROCKFILL-GRAVITY	80AF	1900	1
D32	SAUGUS	WALDEN POND DAM	CITY OF LYNN	DAM/EARTH-GRAVITY	6140AF	1920	3
D33	SOMERVILLE	AMELIA EARHART DAM	M.W.R.A	DAM			3
D34	STONEHAM	FELLS RESERVOIR MID.DIKE	M.W.R.A.	RES./MIDDLE DIKE			1
D35	STONEHAM	MIDDLE RESERVOIR DIKE	TOWN OF WINCHESTER	RESERVOIR/DIKE			2
D36	STONEHAM	SPOT POND RESERVOIR DAM		RESERVOIR	1838MG	1890	1
D37	WAKEFIELD	CRYSTAL LAKE DAM	TOWN OF WAKEFIELD	DAM/EARTH-ROCKFILL	920AF	1883	1
D38	WAKEFIELD	LAKE QUANNAPOWITT DAM	TOWN OF WAKEFIELD	DAM			1
D39	WAKEFIELD	LYNN WATERWAYS DAM	CITY OF LYNN	DAM			2
D40	WALTHAM	BLEACHERY DAM	M.W.R.A	DAM			3
D41	WALTHAM	CAMBRIDGE RESERVOIR DAM	CAMB.WATER BOARD	DAM/GRAVITY-GRAVITY	4780AF	1910	2
D42	WALTHAM	HARDY'S POND DAM	CITY OF WALTHAM	DAM			1
D43	WALTHAM	MOODY STREET DAM	MDC	DAM/GRAVITY-OTHER	2950AF	1900	3
D44	WALTHAM	STONY BROOK RESERVOIR DAM	CITY OF CAMBRIDGE	RESERVOIR DAM	1530AF		3
D45	WATERTOWN	WATERTOWN DAM	M.W.R.A	DAM			3
D46	WINCHESTER	NORTH RESERVOIR DAM	TOWN OF WINCHESTER	DAM/EARTH-GRAVITY	380AF	1900	1
D47	WINCHESTER	WEDGE POND DAM	TOWN OF WINCHESTER	DAM			3
D48	WOBURN	HORN POND DAM	CITY OF WOBURN	DAM			3

KEY
MDC = METROPOLITAN DISTRICT COMMISION
M.W.R.A. = MASSACHUSETTS WATER RESOURCE ASSOCIATION
AF = ACRE-FEET
MG = MILLION GALLONS

TABLE 3.13b (cont.)
SPECIAL FACILITIES
TALL BUILDINGS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	# STORIES	# FEET	STRUCTURAL CLASSIFICATION	YEAR BUILT	APPROXIMATE AREA IN SQUARE FEET	SEISMIC HAZARD
T31	BOSTON	JAMAICAWAY TOWERS	111 PERKINGS ST.	RESIDENTAL	30	320	CONCRETE	1966	335530	1
T32	BOSTON	ONE INTERNATIONAL PLACE	1 INTERNATIONAL PL.	OFFICE	46	600	STEEL	1987		2
T33	BOSTON	ONE INTERNATIONAL PLACE	1 INTERNATIONAL PL.	OFFICE	27	365	STEEL	1987		2
T34	BOSTON	FEDERAL CENTER	150 FEDERAL STREET	OFFICE	28	393	STEEL	1987	727272	3
T35	BOSTON	101 FEDERAL ST.	101 FEDERAL ST.	OFFICE	28	382	STEEL	1987		3
T36	BOSTON	NEW ENGLAND LIFE	501 BOYLESTON ST.	OFFICE	25	330	STEEL	1988	1626025	3
T37	BOSTON	75 STATE ST.	75 STATE ST.	OFFICE	31	390	STEEL	1988	1806990	3
T38	CAMBRIDGE	GREEN BUILDING (M.I.T. BLDG. 54)	21 AMES ST.	RESEARCH	21	295	CONCRETE	1964		3

TABLE 3.13b
SPECIAL FACILITIES
TALL BUILDINGS

CODE	CITY	FACILITY NAME	LOCATION	TYPE OF FACILITY	# STORIES	# FEET	STRUCTURAL CLASSIFICATION	YEAR BUILT	APPROXIMATE AREA IN SQUARE FEET	SEISMIC HAZARD
T 1	BOSTON	JOHN HANCOCK TOWER	200 CLARENDON	OFFICE	60	790	STEEL	1973	3714000	3
T 2	BOSTON	PRUDENTIAL CENTER	800 BOYLESTON	OFFICE	52	750	STEEL	1964	1337700	3
T 3	BOSTON	FEDERAL RESERVE	600 ATLANTIC	OFFICE	32	604	STEEL	1975	2560000	3
T 4	BOSTON	BOSTON COMPANY	1 BOSTON PLACE	OFFICE	41	605	MIXED	1970		3
T 5	BOSTON	1ST NATIONAL BANK OF BOSTON	100 FEDERAL STREET	OFFICE	37	591	STEEL	1970	954600	2
T 6	BOSTON	ONE POST OFFICE SQUARE	MILK STREET	OFFICE	40	507	STEEL	1981		3
T 7	BOSTON	SHAWMUT BANK	MILK STREET	OFFICE	38	520	STEEL	1975	2474472	3
T 8	BOSTON	SIXTY STATE	60 STATE STREET	OFFICE	38	509	STEEL	1978	947200	3
T 9	BOSTON	NEW ENGLAND MERCHANT BANK	28 STATE STREET	OFFICE	40	500	STEEL	1968	1344672	2
T10	BOSTON	U.S. CUSTOM HOUSE	2 INDIA SQUARE	OFFICE	32	496	STEEL	1847/1900		3
T11	BOSTON	JOHN HANCOCK BUILDING	JOHN HANCOCK PL.	OFFICE	26	495	STEEL	1973		3
T12	BOSTON	STATE STREET BANK	225 FRANKLIN STREET	OFFICE	34	477	STEEL	1966	1759296	3
T13	BOSTON	100 SUMMER STREET	100 SUMMER STREET	OFFICE	33	450	STEEL	1975	1361600	2
T14	BOSTON	McCORMICK STATE OFFICE BLDG	1 ASHBURTON PL.	OFFICE	22	401		1933		2
T15	BOSTON	KEYSTONE CUSTODIAN FUNDS	99 HIGH STREET	OFFICE	32	400	STEEL	1971	680544	3
T16	BOSTON	HARBOR TOWERS (2)	85 E. INDIA ROW	RESIDENTAL	40	396	CONCRETE	1970	374000	3
T17	BOSTON	SALTONSTALL OFFICE BUILDING	100 CAMBRIDGE	OFFICE	22	396	STEEL			2
T18	BOSTON	J.F.K. BUILDING	CAMBRIDGE STREET	OFFICE	24	387	STEEL	1964		3
T19	BOSTON	FEDERAL BUILDING & POST OFFICE		OFFICE	22	345	STEEL	1930'S		3
T20	BOSTON	SHERATON BOSTON HOTEL	39 DALTON	RESIDENTAL	29	310	STEEL	1966	498624	3
T21	BOSTON	STATE SERVICE CENTER	STANFORD STREET	OFFICE	23		CONCRETE	1970		2
T22	BOSTON	LONGFELLOW TOWERS	1 LONGFELLOW PL.	RESIDENTAL	38				504495	3
T23	BOSTON	CHARELSBANK APARTMENTS	650 HUNTINGTON	RESIDENTAL	24		CONCRETE	1961		3
T24	BOSTON	SUFFOLK COUNTY COURTHOUSE	PEMBERTON SQUARE	OFFICE	19	330	STEEL	1930'S	3086766	2
T25	BOSTON	WESTIN HOTEL-COPLEY PLACE	10 HUNTINGTON AVE	RESIDENTAL	36	395	MIXED	1983	3098710	3
T26	BOSTON	MARRIOTT HOTEL-COPLEY PLACE	110 HUNTINGTON AVE.	RESIDENTAL	39	383	CONCRETE	1984		3
T27	BOSTON	ONE FINANCIAL CENTER	SUMMER STREET	OFFICE	46	590	STEEL	1984		3
T28	BOSTON	EXCHANGE PLACE	53 STATE STREET	OFFICE	39	510	STEEL	1985		3
T29	BOSTON	ONE BEACON STREET	ONE BEACON STREET	OFFICE	40	507	CONCRETE	1974	1207347	2
T30	BOSTON	THE DEVONSHIRE APARTMENTS	250 WASHING ST.	RESIDENTAL	40	396	CONCRETE	1973		3

TABLE 3.13c
SPECIAL FACILITIES: DAMS
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	1-2	3-4,6	5,7-9
DAMS	21	1	1,750	750	500
		2	250	500	-
		3	500	2,250	2,000

TABLE 3.13d
SPECIAL FACILITIES: TALL BUILDINGS
REPLACEMENT VALUES ($-THOUSANDS)
BY ENGINEERING STRUCTURE CLASS, CELLS, AND ZONES

FACILITY	ENGR. STRUCTURE CLASS	CELLS / ZONES	7
HIGH-RISE REIN. CONC.	8	1	5,280
		2	230,850
		3	663,430
HIGH-RISE STEEL	12	1	18,440
		2	731,040
		3	2,100,870

3.14 Sources of Inventory Data

The inventory data presented in Sections 3.4 through 3.13 were compiled from a number of sources including state and regional agencies, private companies, established experts in different fields, and sampling.

Most often the information required was unavailable, inaccessible, or stored in a manner that made extracting the appropriate data a challenging task. Where data on engineering structure classification were unavailable, on-site and telephone sampling was carried out. The classification of facilities was simplified to four types of structures, and these types were further categorized by number of stories. Telephone sampling was accomplished by interviewing the engineering departments or individuals in various facilities to acquire information regarding type of construction, approximate year of construction, and number of stories. On-site sampling was accomplished by actual observation. When information was provided, it was interpreted, if necessary, in consultation with the agency providing it. The Massachusetts Civil Defense Agency staff was invaluable in assisting with locating, contacting, and interacting with cooperating agencies.

Following are the primary agencies and other sources used to compile the inventory for each of the 10 categories:

3.14.1 Medical Facilities and Resources

- Massachusetts Department of Public Health: Division of Health Facility Regulation
  80 Boylston Street
  Boston, Massachusetts
  - -- 1980 list of licensed hospitals and satellites in Massachusetts
- American Hospital Association
  - -- *AHA Guide to the Health Care Field*, 1984 Edition

- Massachusetts General Hospital: Public Relations Department
- Massachusetts Department of Public Health: Women's Educational and Industrial Union
  - -- 1980 list of levels of care facilities in Massachusetts
- Massachusetts Department of Public Health: Office of Emergency Services
  - -- 1985 listing of ambulance service operators in Massachusetts
  - -- Conversations with field operations supervisor
- Boston Health and Hospitals EMS
  618 Harrison Avenue
  Boston, Massachusetts
  - -- Conversations with supervisor
- Air Ambulance Network, Inc.
- Massachusetts Department of Public Health: Laboratory Quality Division
  - -- 1982 list of hospital-run blood banks in Massachusetts.
- Massachusetts Department of Public Health: Division of Health Care Quality
  - -- Prepared list of hospital and private medical laboratories.
- Massachusetts Department of Public Health: Division of Health Statistics and Research
  - -- 1976 list of licensed health professionals in Massachusetts, excerpted from *Massachusetts Health Data Annual - 1977*
- Folio Associates, Inc.
  111 Perkins Street
  Boston, Massachusetts 02130
  - -- February 1988 listing of physicians by town
- On-site sampling

3.14.2 Transportation Facilities and Systems

- Boston Redevelopment Authority (BRA)
  - -- *Transportation Facts for the Boston Region*, 1983, by Central Transportation Planning Staff

- Metropolitan Boston Transportation Authority (MBTA)
  - -- Phone conversations
  - -- Personal interviews
  - -- Maps
- Boston Shipping Association, Inc.
  - -- Maps of locations and facilities
  - -- *The Port of Boston Handbook 1984-1985*
- Massachusetts Port Authority (Massport)
  99 High Street
  Boston, Massachusetts 02110
  - -- *Boston Port & Shipping Handbook: Sea and Air 1985*
  - -- Massport Public Affairs Department brochure "Boston is the Port of New England"
  - -- Conversations with and notes from Anthony Cecere, Assistant Director of Engineering
- 1984-1985 *Official Massachusetts Transportation Map*
- Massachusetts Aeronautical Charts

3.14.3 Gas and Petroleum Fuels

- Boston Shipping Association, Inc.
- Commonwealth Gas
  - -- Primary gas distribution maps
  - -- Personal interviews
  - -- Maps and data on critical facilities
  - -- Natural gas supplier distribution maps
- Boston Gas Company
  201 Rivermoor Street
  Boston, Massachusetts 02132
  (James F. Drain, Manager of Engineering)
  - -- Service brochure
  - -- Transmission and distribution maps
  - -- Information on LNG tanks
  - -- Personal interviews
  - -- Inventory and locations of inventory items
  - -- Telephone conversations with Charles Buckley, Vice President

- Executive Office of Energy Resources
  Commonwealth of Massachusetts
  100 Cambridge St., 15th Floor
  Boston, Massachusetts 02202
  Joanne McBrien, Research Analyst
  - -- Listing of storage facilities for gasoline and heating oil
- Massachusetts Energy Office
  - -- Listing of storage facilities for large volumes of petroleum fuels

3.14.4 Water and Sewerage Utilities

- Massachusetts Water Resources Authority (MWRA)
  - -- *Massachusetts Water Supply Agencies: Addresses and Contacts, 1983*
  - -- Personal interviews with agency representatives
  - -- Inventory listings and locations (Noel D. Baratta, P.E., Director, Sewerage Division)
- Metropolitan District Commission (MDC)
  William T. Kenney, Director
  - -- MDC metropolitan water system publication/map locating reservoirs and major pipe systems
  - -- MDC 1981 metropolitan sewerage district publication/map locating pipes and treatment centers
  - -- List of maintenance facilities
- City of Cambridge Water Department
  - -- American Water Works Association publication *The Story of Drinking Water*

3.14.5 Electrical Power Utility

- Massachusetts Electric Company
  - -- Maps of North Shore area
  - -- Locations of North Shore substations
  - -- Maps of primary electrical lines

- Commonwealth of Massachusetts: Department of Public Utilities
  100 Cambridge Street
  Boston, Massachusetts 02202

  -- Listing of electrical service areas

- Town of Belmont Municipal Light Department

  -- Maps locating transmission lines and substations

- Boston Edison

  -- Transmission, substation, and generating station maps

- Cambridge Electric Company

  -- Voltage system maps

  -- Maps locating generating plants and substations

  -- Estimated replacement value of system components

3.14.6 Communications Network

- *New England Media Directory - 1980*

  -- Listing of radio, television, and cable television stations

- Federal Communications Commission (FCC)

  -- *TV and Cable Factbook #56* (1988 edition), listing studio and antenna locations

  -- *Broadcasting/Cablecasting Yearbook 1988*

- New England Telephone Company

  -- Proprietary maps of central offices and major trunk lines within the city of Boston

- Telephone sampling of structures

3.14.7 Emergency Public Facilities

- NYNEX telephone directories

  -- Local police stations and headquarters

- Massachusetts Department of Education: Massachusetts Firefighting Academy
  59 Horse Pond Road
  Sudbury, Massachusetts 01776

  -- 1985 fire department chief officers listing

- Metro Fire Stations Cooperative Listing
- Massachusetts Civil Defense Agency and Office of Emergency Preparedness
  400 Worcester Road
  Framingham, Massachusetts 01701
  Ed Fratto (former MCDA earthquake project manager)
  - -- Location of Civil Defense offices, emergency operating centers, and National Guard armories
  - -- Assistance in contacting cooperating agencies
- Massachusetts National Guard
  - -- Telephone conversations with quartermaster
- Sampling

3.14.8 Residential Buildings

- *Patterns of Housing Type and Density: A Basis for Analyzing Earthquake Resistance*, Department of Architecture, Harvard University, Cambridge, Massachusetts, Urs P. Gauchat and Daniel L. Schodek, 1984
- Daniel L. Schodek
  Harvard University Architecture Professor
  - -- Telephone conversations and correspondence
- Bureau of the Census
  - -- Population and metropolitan housing characteristics for standard metropolitan statistical areas (1980)
  - -- Numbers of single, multifamily homes
  - -- Stories per residence
  - -- Year of construction
  - -- Median housing value

3.14.9 School Buildings

- Massachusetts Department of Education
  - -- *A Complete Listing of Massachusetts Schools 1987-88*
- Massachusetts Board of Regents
  - -- 1984 listing of Massachusetts educational institutions authorized to grant degrees

- Tufts University
  Packard Avenue
  Medford, Massachusetts
  - -- Campus map/literature
- Harvard and Radcliffe Universities
  Massachusetts Avenue
  Cambridge, Massachusetts
  - -- Campus map/literature
- Boston University
  765 Commonwealth Avenue
  Boston, Massachusetts
  - -- Campus map/literature
- Boston College
  Chestnut Hill
  Boston, Massachusetts
  - -- Campus map
- Massachusetts Institute of Technology
  77 Massachusetts Avenue
  Cambridge, Massachusetts
  - -- Campus map
- On-site sampling

3.14.10 Special Facilities

- Department of the Army, Corps of Engineers
  - -- Federal dam analysis and Phase I inspection reports
  - -- Personal interviews with Waltham office
  - -- Maps locating dams in metropolitan Boston
- Boston Redevelopment Authority (BRA)
  1 City Hall Square
  Boston, Massachusetts
  - -- Listing of tall buildings from the *World Almanac*

4. LOSS ESTIMATION METHODOLOGY

4.1 Introduction

Earthquake loss estimation is a relatively new area of earthquake engineering. This is why a comprehensive methodology to perform these studies, one that has the consensus of the professional community, is not currently available. In the past, many earthquake loss studies were based on the subjective judgment of a few recognized earthquake experts. These reports usually gave the estimates of damage and casualties but did not elaborate on the methodology used to arrive at these estimates. This made these studies difficult to duplicate by others since they depended so heavily on the experience and intuition of the experts performing the study. Recently, several loss studies have been performed with methodologies that are less dependent on the opinion and judgment of the researcher (References 7 through 12). However, a review of these studies shows that there is no common methodology used and that there is still a substantial amount of judgment exercised by the authors that cannot be duplicated analytically.

The report titled *Earthquake Damage Evaluation Data for California* (ATC-13) presents the most comprehensive methodology to date to conduct an earthquake loss study. The Metropolitan Boston Area Earthquake Loss Study has drawn heavily on the basic approach proposed in ATC-13 because it is more rational and tractable than the others proposed thus far, and the results can be scrutinized by others and the effects of varying opinions assessed. However, the ATC-13 methodology has not yet been applied to test the practicability of its use and its inherent limitations and shortcomings. It was found that some of the components of the ATC-13 methodology were either not applicable to the Metropolitan Boston Area Earthquake Loss Study or not acceptable to the panel of experts assembled for this study. Hence, the details of the ATC-13 methodology were changed substan-

tially, as described below, although the overall approach was closely adhered to.

The methodology described here attempts to provide a best estimate of the damage cost, loss of functionality of critical facilities, and casualties in metropolitan Boston due to the postulated earthquake. This is attempted within limitations of the available data and the state of the art of estimating earthquake losses. It is recognized that there is substantial *uncertainty* in the component parts of the loss study (e.g., definition of seismic hazard, inventory, cost of replacement) that can be reduced by allocating more effort and resources to the study. However, there is also a significant level of *randomness* in the response of structures and people to earthquakes that is inherent in the phenomenon and cannot be removed by expanded effort. This study does not attempt to quantify the uncertainty or randomness in the process of loss estimation. The objective of the study is to produce estimates that are in keeping with the current earthquake experience data base and the prevalent opinion of the mainstream of the professional community. Respected experts will likely disagree with individual aspects of the methodology and be able to suggest improvements; however, we believe that the methodology described below is rational and that the estimates of damage and casualties resulting from its use are reasonable best estimates.

Section 1.3 gives an overview of the loss estimation methodology. Following is a detailed discussion of the classification system, methodology to develop damage probability matrices and loss modeling, methodology to estimate loss of functionality of critical facilities, and methodology to estimate casualties.

4.2 Classification Systems

A classification system for distinguishing both the engineering characteristics of structures and the societal uses of structures is cen-

[illegible]

[illegible]

[illegible]

[illegible]

[illegible]

tral to the loss estimation methodology proposed here. The system is necessary to establish the level of detail and the categories of structures and facilities to be considered in the inventory. It is also necessary for the development of damage probability matrices because it establishes the engineering characteristics to be considered in each building class. Furthermore, it is needed to estimate the loss of functionality and casualties. Three classifications have been developed for this study. Two are related to the engineering characteristics of the structures and the third to the social function of the facilities.

4.2.1 Engineering Classification. Even though each structure's response to an earthquake is unique, an areawide earthquake loss study requires that structures be grouped into broad classes for which overall response is expected to be similar. The engineering characteristics most significant in determining possible earthquake damage are construction material, load-resisting system, and size. There is no unique way of developing an engineering structure classification. An extensive classification system will give more detailed results but will substantially increase the effort to compile an inventory and develop structure fragilities. Hence, a classification system is always a tool to limit the scope of an areawide earthquake loss study to within available budgets and schedules while also maintaining the technical integrity of the loss estimation. Various researchers have prepared different classification systems for specific studies. For example, the ATC-13 project for California [7] developed a 79-class classification scheme, the Federal Emergency Management Agency (FEMA) six-city study [11] has 16 classes, and an NSF-supported Boston project [12] has a 17-class scheme for houses in the Boston area.

This study uses two engineering structure classifications, one to compile the inventory and one to develop DPMs. The reason for having two sets of engineering classifications is dictated by constraints of

the inventory methodology and the requirements for developing DPMs. The inventory methodology is based on publicly available data and sampling.

Table 4.1 gives the two sets of engineering structure classifications. The engineering classification used to develop DPMs is a subset of the one used for the inventory. The correlation between the two (e.g., the percentages of the various types of masonry buildings within that class of construction) is based on expert opinion.

4.2.2 Social Function Classification. The ability of society to function after a damaging earthquake is directly related to the post-earthquake residual function of its critical facilities. Hence, an estimate of the loss of functionality of these facilities is of primary importance for emergency planning and hazard mitigation considerations. This study considers 48 social function classifications, shown in Table 4.2, which satisfy the scope of the work as determined by the MCDA.

4.3 Structure Fragilities--Damage Probability Matrices

As discussed in Section 1.3, this study uses DPMs to estimate losses. To fully describe the development of DPMs, we use the concept of damage factor (DF):

$$DF = \frac{\text{Dollar Loss}}{\text{Replacement Value}} \qquad (4.1)$$

The replacement value of a structure is defined as the cost of a new structure that is similar in kind.

Clearly, the DF as defined above is a random variable with values of 0 to 1.0, where 0 represents no damage and 1.0 represents total collapse. The loss estimation has been significantly simplified by discretizing the DF into seven ranges and defining a central damage fac-

TABLE 4.1

ENGINEERING STRUCTURE CLASSIFICATIONS

Structure Type	Structure Classification for DPM	Structure Classification for Inventory	Classification Number
Wood Frame	*	low-rise	1
	*	medium-rise	2
Masonry	low-rise, pre-1975 low-rise, post-1975	low-rise	3
	medium-rise, pre-1975 medium-rise, post-1975	medium-rise	4
	*	high-rise	5
Reinforced Concrete	low-rise, pre-1975 low-rise, post-1975 low-rise, precast	low-rise	6
	medium-rise, conventional R/C medium-rise, precast	medium-rise	7
	high-rise, conventional R/C high-rise, precast	high-rise	8
Steel	*	light metal low-rise	9
	*	low-rise	10
	*	medium-rise	11
	*	high-rise	12
Bridges	*	multiple simple-span	13
	*	continuous span	14
Tanks	*	on ground	15
	*	elevated	16
Towers	*	lower than 100 ft	17
	freestanding guyed	higher than 100 ft	18
Tunnels	*	tunnels	19
Pipelines	*	pipelines	20
Dams	*	dams	21
Electrical Substations	*	electrical substations	22
Waterfront Facilities	*	docks	23
	*	cranes	24
Equipment	*	electrical	25
	*	mechanical	26

* Same as for inventory

TABLE 4.2

SOCIAL FUNCTION CLASSIFICATION

RESIDENTIAL

1. Permanent Dwellings
2. Temporary Lodging
3. Group Institutional Housing

COMMERCIAL

4. Professional, Technical, and Business Services
5. Retail and Wholesale Trade
6. Health Care
7. Parking
8. Entertainment and Recreation

INDUSTRIAL

9. Large Places of Fabrication and Assembly
10. High Technology

GOVERNMENT

11. General Services
12. Emergency Response Services
    - Police
    - Fire
    - Civil Defense
    - National Guard

EDUCATION

13. Schools

PETROLEUM FUEL

14. Transmission Lines
15. Distribution Storage Tanks

TRANSPORTATION

16. Highway System, Major Bridges
17. Highway System, Tunnels
18. Highway System, Conventional Bridges
19. Highway System, Freeways and Conventional Highways

TABLE 4.2 (Continued)

20. Railway System, Railway Bridges
21. Railway System, Railway Tunnels
22. Railway System, Railways
23. Air Transportation, Terminals, Towers, and Other Buildings
24. Air Transportation, Runways and Taxiways

25. Waterfront, Ports
26. Waterfront, Cargo Handling Equipment

UTILITIES

27. Electricity, Generating Facilities
28. Electricity, Transmission Lines
29. Electricity, Transmission Substations
30. Electricity, Distribution Lines
31. Electricity, Distribution Substations

32. Water Supply, Transmission Lines
33. Water Supply, Pumping Stations
34. Water Supply, Storage Reservoirs
35. Water Supply, Treatment Plants
36. Water Supply, Terminal Reservoirs/Storage Facilities

37. Sanitary Sewer, Effluent Lines
38. Sanitary Sewer, Booster Pumping Stations
39. Sanitary Sewer, Treatment Plants

40. Natural Gas, Transmission Lines
41. Natural Gas, Low Pressure Holders
42. Natural Gas, Compressor Stations, Plants, Terminals, and Storage Facilities
43. Natural Gas, Distribution Feeder Lines

COMMUNICATIONS

44. Telephone and Telegraph, Regional Switching Offices
45. Telephone and Telegraph, Interregional Switching Offices

46. Broadcast Stations
47. Transmission Towers

FLOOD CONTROL

48. Dams

tor (CDF) for each of the damage states. The seven CDF values used in this study, and their relationship to the damage states, are shown in Table 4.3. Given the above definitions, structure fragilities can be given in terms of a DPM as shown in Table 4.4. The numbers given in this matrix are the probabilities that a class of structures will sustain a given CDF for various levels of shaking. As an example, the DPM given in Table 4.4 states that, for the given class of structures and an MMI of X, there is a 19% probability that the structures will have a CDF of 5.0, a 54% probability that the structures will have a CDF of 20.0, and a 25% probability that the structures will have a CDF of 45.0.

The three basic sources of information to arrive at the probabilities for a DPM like the one shown in Table 4.4 are analytical studies, earthquake damage data, and expert opinion.

Analytical approaches have been widely used in probabilistic risk assessments of nuclear power plants and site-specific loss studies. This approach, in general, attempts to quantify the probability of damage on the basis of dynamic analytical models of the structures, data on materials and tests of structural components, expert opinion, and probabilistic techniques to analyze the uncertainty and randomness in the predicted response of the structure to a given level of seismic motion. Although this approach is well suited to site-specific loss studies, it is not practical for areawide studies, which contain a large population of structures.

Damage data from previous earthquakes would be extremely useful to use as the basis for DPMs. Unfortunately, the available damage data are not numerous enough to constitute a sufficient data base. Furthermore, the data are not consistent because researchers and engineers visiting sites of earthquake damage do not follow a standard survey format.

TABLE 4.3

CORRELATION OF DAMAGE STATE, DAMAGE FACTOR, AND CENTRAL DAMAGE FACTOR

Damage State, DS	Damage Factor Range, DF (%)	Central Damage Factor, CDF (%)
1 - None	0	0.00
2 - Slight	0 - 1	0.50
3 - Light	1 - 10	5.00
4 - Moderate	10 - 30	20.00
5 - Heavy	30 - 60	45.00
6 - Major	60 - 100	80.00
7 - Destroyed	100	100.00

TABLE 4.4

DAMAGE PROBABILITY MATRIX (DPM) FOR WOOD BUILDINGS IN CALIFORNIA

	Modified Mercalli Intensity						
CDF (%)	VI	VII	VIII	IX	X	XI	XII
0.00	5.1	3.0	*	*	*	*	*
0.50	42.4	30.4	8.2	1.4	1.0	*	*
5.00	49.8	59.5	72.4	51.0	19.1	12.9	5.5
20.00	2.7	7.1	19.1	46.1	54.5	55.6	35.3
45.00	*	*	*	1.5	25.3	30.8	53.2
80.00	*	*	*	*	*	*	*
100.00	*	*	*	*	*	*	*

*Very small probability

Expert opinion has successfully been used for developing DPMs. Approaches have ranged from the most simplistic, whereby one or two experts have informally converged on a set of probabilities, to the more sophisticated, whereby opinions of a large number of experts have been collected and combined statistically to develop DPMs. The most comprehensive DPMs based on expert opinion to date are those developed for ATC-13. In this data base, a large number of earthquake experts were asked to give their opinion of estimates of damage to a detailed list of California structural engineering classifications for seismic hazards ranging from MMI VI to XII. The Delphi method used for solicitation of expert opinions is described in detail in the ATC-13 report. Briefly, three iterations were used to collect the data. Each expert gave a rating of 0-10 of his individual expertise and confidence in the damage estimates for each class of structure. Furthermore, each expert gave three estimates of DF for each MMI level, a low, best, and high estimate. These three estimates were intended to represent the expert's opinion of the variability in the DF due to a large number of complex factors that can lead to different levels of damage to the same class of structures subjected to the same level of shaking. The following are some of the principal factors contributing to this variability.

a. The MMI scale is a rather ambiguous measure that attempts to characterize the intensity of ground motion by the damage it causes to certain buildings and by the sensations of people in the stricken area. The damage to buildings is not due to the intensity of ground motion alone, but also to the building's age, quality of construction, and other building characteristics. Thus, estimates of ground motion intensity based on building damage can have considerable uncertainty.

   Also, sensations of people in a stricken area are very ambiguous to measure and to correlate with earthquake intensity.

b. Earthquake motions may change within small distances due to local soil conditions and geologic features in the study area. These microzonation effects are very

difficult to model using the MMI scale. This may introduce uncertainty in the estimates of structural damage from a given level of MMI.

c. A classification system, by definition, attempts to group large numbers of structures into a single class on the basis of a limited number of parameters, such as height and construction material. However, structural damage also depends on the quality of construction, age of the building, details of the joints between structural elements, building configuration, and many other parameters. Hence, individual buildings within a class may behave substantially differently.

The methodology used to combine expert opinion in the ATC-13 study was reviewed and determined to be inadequate for the purposes of this study. A different approach was used to combine the raw expert opinion collected in ATC-13 to define California DPMs. This approach is summarized as follows:

a. The difference between the low and high estimates of damage is assumed to represent a 90% interval in the probability distribution of the DF, as defined by each expert. This is the same as was assumed in the ATC-13 study.

b. The raw expert opinions are weighed by the experience rating of each expert, rather than by the experience and confidence ratings, as was done in ATC-13. This is done to resolve problems where experts with limited experience gave rather high confidences in their estimates, or vice versa, which introduced unacceptable confusion into the process of combining expert opinion.

c. The final DF estimate from combining the expert opinion is considered to be a bounded random variable with a range of 0 to 1.0. The parameters of the probability of the random variable DF are considered to be a standard deviation and a mean.

d. The standard deviation of the DF is considered to be the weighted average from the standard deviations calculated for each expert.

e. The mean of the DF is considered to be a random variable whose mean is the weighted average of the best

estimate of the expert opinion and whose standard deviation is the weighted statistical standard deviation of the best estimates of the expert opinion.

f. Bayesian updating methodology is used to calculate the probability distribution of DF, which has a deterministic standard deviation and a random mean.

g. The Bayesian updating is simplified by first mapping the bounded random variable DF to another unbounded random variable y, such that:

$$y = \ln\left(-\ln \frac{DF}{100}\right) \tag{4.2}$$

Bayesian updating is used to develop the probability distribution of y, where:

$$P_y(y) = \frac{1}{\sqrt{2\pi}(\sigma^2 + \sigma_{\bar{y}}^{\prime\prime 2})^{1/2}} \exp\left\{-\frac{1}{2}\left[\frac{y - \bar{y}}{\sqrt{\sigma^2 + \sigma_{\bar{y}}^{\prime\prime 2}}}\right]^2\right\} \tag{4.3}$$

where:

$P_y(y)$ = probability distribution of unbounded variable y

σ = sample variance from expert opinions

$\bar{y}$ = average of the best estimates from expert opinion (sample mean)

$\sigma'_{\bar{y}}$ = standard deviation of the best estimates from expert opinion

$\sigma''_{\bar{y}} = \sigma\,\sigma'_{\bar{y}}\left[\frac{1}{\sqrt{\sigma^2 + m\sigma_{\bar{y}}^{\prime 2}}}\right]$

Equations 4.2 and 4.3 are used to combine the expert opinion collected in ATC-13 to calculate a new DPM for California structures. Table 4.4 gives the DPM for wood structures in California.

Transferring the California DPM to a Boston DPM is done by a transfer function defined by expert opinion. The project's panel of experts were each asked to estimate transfer functions by correlating DFs for Boston structures when the same classification of California structures has DFs equal to 1%, 20%, and 60%. As an example, the experts were asked to give their estimate of DFs for Boston wood frame residences, if wood frame residences in California, when subjected to the same MMI, sustained DFs of 1%, 20%, and 60%. The estimates of the panel of experts were combined by averaging to develop transfer functions for each engineering classification. Figure 4-1 gives the resulting transfer function for low-rise wood structures, which shows that, for this engineering classification, the MMI that produces a 10% DF in an average California building will cause 10.1% DF in a comparable Boston building. These transfer functions were then used to calculate Boston DPMs from California DPMs by direct multiplication. Table 4.5 gives the Boston DPMs for MMI VI and VII used in this study.

4.4 Estimates of Direct Damage

Given the inventory of structures, and the Boston DPMs, as described in Section 4.3, the estimates of direct dollar damage to a given class of structures are calculated as follows:

$$(\$\ \text{Damage})_{ijx} = (\$\ \text{Replacement Value})_{ijx} \sum_{k=1}^{7} (\text{DPM})_{ikj} (\text{CDF})_k \qquad (4.4)$$

where:

$(\$\ \text{Damage})_{ijx}$ = Dollar damage to structure class i for MMI shaking level j in cell x

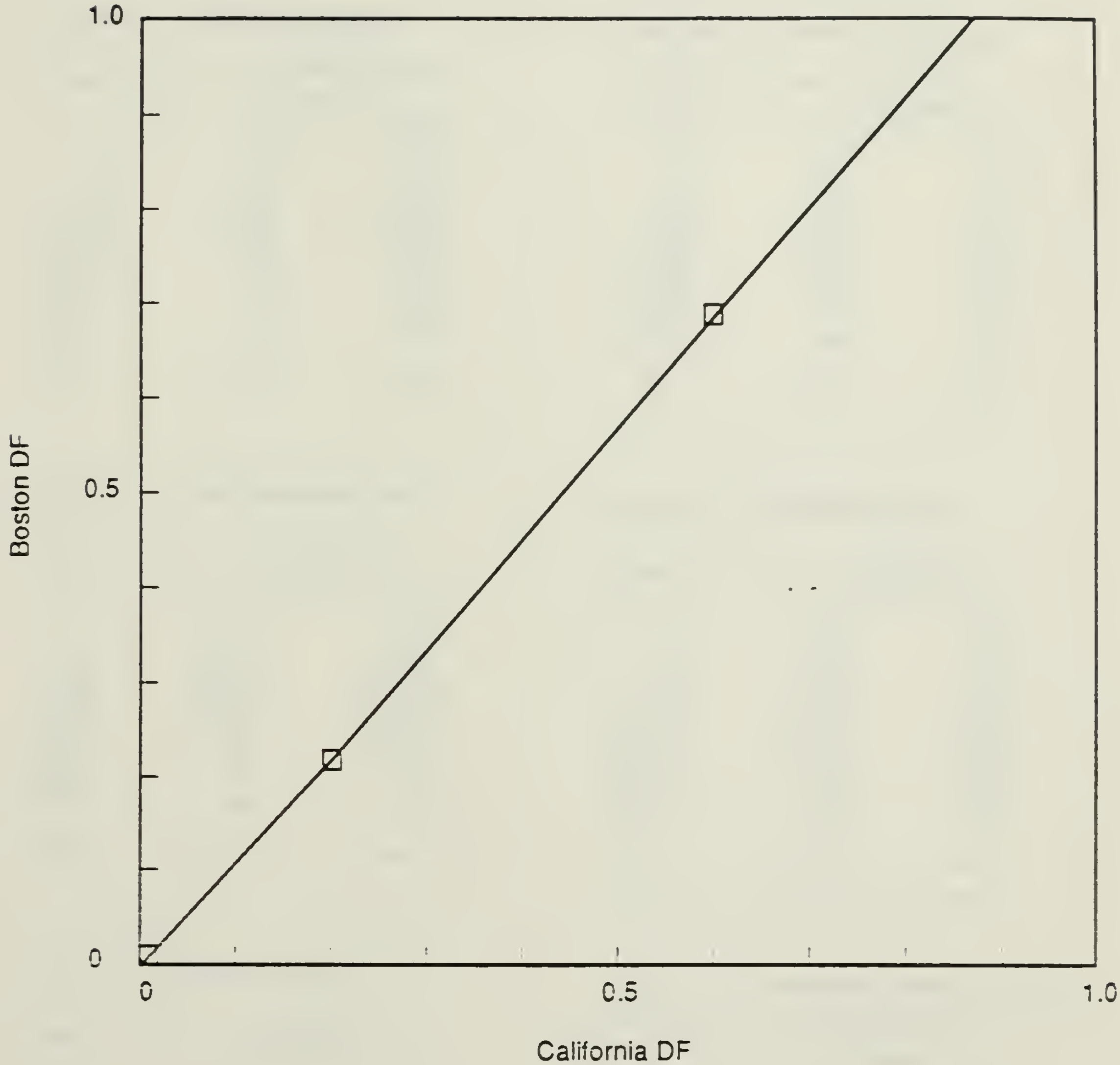


FIGURE 4.1 Transfer Function from California DPMs to Boston DPMs for Wood Buildings

TABLE 4.5

DAMAGE PROBABILITY MATRICES FOR

ENGINEERING STRUCTURE CLASSES IN BOSTON

Class No. 1 : WOOD FRAME LOW RISE

CDF	Intensity VI	Intensity VII
.00	5.10	2.95
.50	36.33	26.04
5.00	51.35	58.49
20.00	6.91	11.64
45.00	.32	.86
80.00	.00	.02
100.00	.00	.00
MDF	4.28	5.78

Class No. 2 : WOOD FRAME MEDIUM RISE

CDF	Intensity VI	Intensity VII
.00	4.02	2.96
.50	34.79	25.79
5.00	42.48	44.51
20.00	17.20	22.95
45.00	1.50	3.75
80.00	.01	.04
100.00	.00	.00
MDF	6.42	8.66

Class No. 3 : MASONRY LOW RISE

CDF	Intensity VI	Intensity VII
.00	2.34	.67
.50	12.86	4.59
5.00	53.01	37.69
20.00	27.40	37.60
45.00	4.33	17.66
80.00	.06	1.79
100.00	.00	.01
MDF	10.19	18.81

Class No. 4 : MASONRY MEDIUM RISE

CDF	Intensity VI	Intensity VII
.00	1.67	.59
.50	7.24	3.21
5.00	43.17	31.19
20.00	36.40	39.00
45.00	10.99	22.74
80.00	.54	3.26
100.00	.00	.02
MDF	14.85	22.23

Class No. 5 : MASONRY HIGH RISE

CDF	Intensity VI	Intensity VII
.00	2.26	.59
.50	8.07	3.09
5.00	34.49	23.18
20.00	39.57	37.69
45.00	14.77	31.23
80.00	.83	4.21
100.00	.00	.01
MDF	17.00	26.15

Class No. 6 : REINFORCED CONCRETE LOW RISE

CDF	Intensity VI	Intensity VII
.00	4.45	.86
.50	38.61	15.24
5.00	49.92	66.46
20.00	6.84	16.02
45.00	.17	1.41
80.00	.00	.01
100.00	.00	.00
MDF	4.14	7.24

TABLE 4.5 (Continued)

Class No. 7 : REINFORCED CONCRETE MEDIUM RISE

CDF	Intensity	
	VI	VII
.00	5.01	.47
.50	38.07	12.30
5.00	45.91	64.93
20.00	10.66	20.46
45.00	.35	1.84
80.00	.00	.00
100.00	.00	.00
MDF	4.78	8.23

Class No. 8 : REINFORCED CONCRETE HIGH RISE

CDF	Intensity	
	VI	VII
.00	4.63	.26
.50	33.93	6.73
5.00	40.35	47.13
20.00	20.48	36.58
45.00	.61	9.25
80.00	.00	.06
100.00	.00	.00
MDF	6.56	13.92

Class No. 9 : STEEL LIGHT METAL LOW RISE

CDF	Intensity	
	VI	VII
.00	8.14	3.21
.50	57.66	36.48
5.00	33.91	57.73
20.00	.30	2.58
45.00	.00	.00
80.00	.00	.00
100.00	.00	.00
MDF	2.04	3.59

Class No. 10 : STEEL LOW RISE

CDF	Intensity	
	VI	VII
.00	6.12	2.05
.50	41.52	24.26
5.00	47.12	63.06
20.00	5.09	10.07
45.00	.14	.55
80.00	.00	.00
100.00	.00	.00
MDF	3.65	5.54

Class No. 11 : STEEL MEDIUM RISE

CDF	Intensity	
	VI	VII
.00	5.34	.41
.50	32.89	9.26
5.00	43.84	55.07
20.00	16.91	30.60
45.00	1.01	4.65
80.00	.00	.01
100.00	.00	.00
MDF	6.20	11.02

Class No. 12 : STEEL HIGH RISE

CDF	Intensity	
	VI	VII
.00	5.59	.62
.50	34.20	11.51
5.00	40.56	50.50
20.00	18.70	32.73
45.00	.94	4.63
80.00	.00	.01
100.00	.00	.00
MDF	6.37	11.22

TABLE 4.5 (Continued)

Class No. 13 : BRIDGES MULTIPLE SIMPLE SPAN

CDF	Intensity VI	Intensity VII
.00	7.43	2.76
.50	57.47	24.55
5.00	34.88	55.28
20.00	.22	16.37
45.00	.00	1.04
80.00	.00	.00
100.00	.00	.00
MDF	2.08	6.63

Class No. 16 : TANKS ELEVATED

CDF	Intensity VI	Intensity VII
.00	8.92	2.10
.50	16.71	7.75
5.00	56.09	42.85
20.00	18.23	44.18
45.00	.04	3.10
80.00	.00	.00
100.00	.00	.00
MDF	6.55	12.42

Class No. 14 : BRIDGES CONTINUOUS SPAN

CDF	Intensity VI	Intensity VII
.00	12.04	6.20
.50	65.67	48.84
5.00	22.21	43.78
20.00	.07	1.18
45.00	.00	.00
80.00	.00	.00
100.00	.00	.00
MDF	1.45	2.67

Class No. 17 : TOWERS LOWER THAN 100 FT

CDF	Intensity VI	Intensity VII
.00	14.83	6.37
.50	35.97	23.23
5.00	45.27	54.85
20.00	3.92	14.78
45.00	.00	.77
80.00	.00	.00
100.00	.00	.00
MDF	3.23	6.16

Class No. 15 : TANKS ON GROUND

CDF	Intensity VI	Intensity VII
.00	7.53	2.94
.50	57.75	33.11
5.00	34.50	59.82
20.00	.21	4.12
45.00	.00	.01
80.00	.00	.00
100.00	.00	.00
MDF	2.06	3.99

Class No. 18 : TOWERS HIGHER THAN 100 FT

CDF	Intensity VI	Intensity VII
.00	5.09	2.66
.50	47.20	30.34
5.00	46.79	61.31
20.00	.91	5.66
45.00	.00	.03
80.00	.00	.00
100.00	.00	.00
MDF	2.76	4.36

TABLE 4.5 (Continued)

Class No. 19 : TUNNELS

CDF	Intensity	
	VI	VII
.00	21.05	6.94
.50	74.07	54.90
5.00	4.88	37.79
20.00	.00	.36
45.00	.00	.00
80.00	.00	.00
100.00	.00	.00
MDF	.61	2.24

Class No. 20 : PIPELINES

Breaks/mile	Intensity	
	VI	VII
.00	20.35	15.93
.25	77.28	76.06
.75	2.37	8.01
5.50	.00	.00
15.00	.00	.00
30.00	.00	.00
40.00	.00	.00
MBPM	.21	.25

Class No. 21 : DAMS

CDF	Intensity	
	VI	VII
.00	18.62	8.30
.50	75.65	60.41
5.00	5.73	31.16
20.00	.00	.13
45.00	.00	.00
80.00	.00	.00
100.00	.00	.00
MDF	.66	1.89

Class No. 22 : ELECTRICAL SUBSTATIONS

CDF	Intensity	
	VI	VII
.00	5.29	1.78
.50	48.32	24.03
5.00	45.60	65.73
20.00	.79	8.39
45.00	.00	.06
80.00	.00	.00
100.00	.00	.00
MDF	2.68	5.11

Class No. 23 : WATERFRONT DOCKS

CDF	Intensity	
	VI	VII
.00	6.93	2.21
.50	48.15	23.32
5.00	42.91	60.06
20.00	2.00	13.97
45.00	.01	.44
80.00	.00	.00
100.00	.00	.00
MDF	2.79	6.11

Class No. 24 : WATERFRONT CRANES

CDF	Intensity	
	VI	VII
.00	8.00	2.11
.50	57.29	30.48
5.00	34.41	64.19
20.00	.31	3.21
45.00	.00	.00
80.00	.00	.00
100.00	.00	.00
MDF	2.07	4.01

TABLE 4.5 (Continued)

Class No. 25 : EQUIPMENT, ELECTRICAL

CDF	Intensity VI	Intensity VII
.00	5.29	1.78
.50	48.32	24.03
5.00	45.60	65.73
20.00	.79	8.39
45.00	.00	.06
80.00	.00	.00
100.00	.00	.00
MDF	2.68	5.11

Class No. 26 : EQUIPMENT, MECHANICAL

CDF	Intensity VI	Intensity VII
.00	4.95	.84
.50	53.49	19.48
5.00	41.40	74.26
20.00	.16	5.42
45.00	.00	.01
80.00	.00	.00
100.00	.00	.00
MDF	2.37	4.90

$(\$ \text{ Replacement Value})_{ijx}$ = Dollar replacement value for structure class i in cell x and MMI j

$(DPM)_{ikj}$ = Damage probability for MMI j, CDF k, and structure class i

CDF = Central damage factor as described in Table 4.3

4.5 Loss of Functionality Modeling

Postearthquake recovery is directly proportional to the availability and functionality of lifelines and critical facilities. There is a heightened demand on these facilities because society attempts to meet the needs of the injured and the homeless while returning the local economy, schools, hospitals, etc., to normal status as soon as possible. The heightened demand on these facilities is aggravated by the fact that the facilities themselves are damaged by the earthquake. Hence, it is extremely important for disaster planning to have a reasonable estimate of the functionality of critical facilities and lifelines. In this study, a methodology has been developed to give a best estimate of the loss of functionality of these facilities during the first 72 hours after the earthquake.

Previous major earthquakes have shown that people seem to rise to the occasion after the initial shock of the disaster and show great cooperation and resourcefulness in dealing with the immediate effects of the earthquake, especially on critical facilities and lifelines. However, it is also possible to postulate scenarios where certain combinations of damage to critical facilities can immobilize society and render it helpless to face the consequences of the earthquake. The 1906 San Francisco earthquake is an example in which a combination of factors led to an uncontrolled conflagration that destroyed large tracts of the city and led to partial evacuation of the populace.

Unlike direct physical earthquake damage, which is primarily a function of the characteristics of the individual structure and the intensity of shaking it undergoes, the loss of functionality of one critical facility or lifeline is dependent on the functionality of other facilities, as described below.

4.6 Loss of Functionality of Lifelines

Lifelines are special systems (networks) that represent the infrastructure that modern urban societies depend on for almost all economic and social activity. They include the systems that deliver energy and water, transportation systems, and communication systems. In general, each network has within it sources (e.g., reservoirs and power plants), transmission lines, storage, and a distribution or collection system.

It is convenient for the purposes of an earthquake loss study to consider lifelines to be composed of main components, distribution components, and service components. In this idealization, the main components are associated with those sections of the system involved with servicing the whole area. As an example, the main components of an electric lifeline will include those involved with producing the electricity (e.g., power plants) and those involved with delivery to large urban areas (e.g., main transmission lines and switchyards). Distribution components are associated with those sections of the system involved with distribution or collection between the main system and the service components. Service components are associated with those sections of the system involved primarily with connecting individual users to the lifeline. Table 4.6 identifies the main and distribution components for the lifelines considered in this study.

The loss of functionality of lifelines is a complex phenomenon that does not lend itself easily to comprehensive analytical procedures. This is because it depends, among other parameters, on the direct

TABLE 4.6

DESIGNATION OF LIFELINE MAIN AND DISTRIBUTION COMPONENTS

Lifeline	Component	Designation
Water	Aqueducts	Main
	Tunnels	Main
	Reservoirs	Main
	Treatment Plants	Main
	Storage Facilities	Distribution
	Pressure Control Facilities	Distribution
	Distribution Pipelines	Distribution
Severage	Outfalls	Main
	Treatment Plants	Main
	Tunnels	Main
	Headworks	Distribution
	Pumping Stations	Distribution
	Interceptor/Collector Lines	Distribution
Electric Power	Generating Stations	Main
	Major Transmission Lines	Main
	Major Substations	Main
	Distribution Substations	Distribution
Natural Gas	Terminal, Plant, or Storage Facilities	Main
	High Pressure Lines	Main
	Metering Stations	Distribution
	Regulator Stations	Distribution
	Intermediate Pressure Lines	Distribution
	Maintenance/Garage Facility	Distribution
Petroleum Fuel	Storage Facilities	Main
Highways	Elevated Highways	Main
	Major Bridges	Main
	Tunnels	Main
	Freeway Interchanges	Distribution
Railways (Public Transport)	Major Bridges	Main
	Terminals	Main
	Maintenance Garages	Distribution

TABLE 4.6 (Continued)

Lifeline	Component	Designation
Air Transport	Terminal Buildings	Main
	Control Towers	Main
	Hangars/Support Facilities	Distribution
Water Transport	Docks	Main
	Cranes	Main
Telephone Communications	Central Offices	Main
Radio and TV	Broadcast Stations	Main
	Transmission Towers	Main

Note: This table does not include runways and taxiways, railways, highways, and pole-mounted electric power distribution lines because damage to these facilities is expected to be inconsequential for the postulated earthquake.

earthquake damage to components; on the interdependence of the main, distribution, and service components; and on the interdependence between the various lifelines.

4.6.1 Loss of Functionality of Lifelines Due to Direct Earthquake Damage. The principal cause of loss of lifeline functionality is direct earthquake damage to components. This can consist of breaks in the transmission or collection lines; equipment failure, such as toppling of transformers in switchyards; or failure of buildings, such as the control tower of an airport.

The loss of functionality of a lifeline component as a function of direct damage is a stochastic process (i.e., it varies with time after the earthquake). In other words, the loss of functionality will change as remedial action begins immediately after the earthquake and society begins to respond to the crises precipitated by the earthquake. Experience shows that some components can be expected to be back in service only hours after the earthquake while other components may take months, or even years, to be brought back to full functionality. The correlation between direct damage, time after the earthquake, and loss of functionality must be based on expert opinion at this time. Sufficient data from previous earthquakes are not currently available to develop such correlations by statistical treatments or by developing analytical models.

This loss study has developed correlations between direct damage and component functionality at 72 hours after the earthquake from expert opinion data collected for the ATC-13 study. A large number of experts offered the ATC-13 study their opinion as to the number of days needed to recover 30%, 60%, and 100% of a component's functionality, given a level of direct earthquake damage. Each expert also rated their levels of expertise on a scale of 1 to 10, with 1 representing low expertise for the given component class and 10 representing high expertise. The three percentages were used in a regression analysis

to calculate component functionality 72 hours after the earthquake (3-day functionality), given the damage state (CDF) after the earthquake. The best estimate and standard deviation of the 3-day functionality for all experts were calculated as follows:

$$F_{ij} = \frac{\sum_{k=1}^{n} C_k F_{ijk}}{\sum_{k=1}^{n} C_k} \qquad (4.5)$$

$$\sigma_{fij} = \left\{ \frac{\sum_{k=1}^{n} C_k (F_{ijk} - F_{ij})^2}{\sum_{k=1}^{n} C_k} \right\}^{1/2} \qquad (4.6)$$

where:

F_{ij} = best estimate of 3-day functionality of component i for damage state j

F_{ijk} = best estimate of 3-day functionality of component i for damage state j given by expert k

C_k = self-rating of expertise by expert k

σ_{fij} = standard deviation of 3-day functionality for component i and damage state j

n = total number of experts

Table 4.7 gives the best estimate and standard deviation for component 3-day functionality used in this study.

TABLE 4.7

FUNCTIONALITY OF SOCIAL FUNCTION CLASSES 72 HOURS AFTER THE POSTULATED EARTHQUAKE

Class 1 : PERMANENT DWELLINGS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	91.8	20.7
3	5.0	75.6	36.2
4	20.0	49.1	29.6
5	45.0	10.3	9.9
6	80.0	2.4	1.2
7	100.0	.0	.0

Class 2 : TEMPORARY LODGING

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	91.8	20.7
3	5.0	75.6	36.2
4	20.0	49.1	29.6
5	45.0	10.3	9.9
6	80.0	2.4	1.2
7	100.0	.0	.0

Class 3 : GROUP INSTITUTIONAL HOUSING

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	91.8	20.7
3	5.0	75.6	36.2
4	20.0	49.1	29.6
5	45.0	10.3	9.9
6	80.0	2.4	1.2
7	100.0	.0	.0

Class 4 : PROFESSIONAL, TECHNICAL, AND BUSINESS SERVICES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	77.9	35.8
3	5.0	51.1	37.9
4	20.0	14.8	12.2
5	45.0	2.7	1.9
6	80.0	1.1	.6
7	100.0	.0	.0

Class 5 : RETAIL AND WHOLESALE TRADE

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	77.9	35.8
3	5.0	51.1	37.9
4	20.0	14.8	12.2
5	45.0	2.7	1.9
6	80.0	1.1	.6
7	100.0	.0	.0

Class 6 : HEALTH CARE

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	67.9	44.1
3	5.0	44.0	36.5
4	20.0	11.0	10.4
5	45.0	2.0	1.4
6	80.0	.8	.5
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 7 : PARKING

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	63.8	24.4
4	20.0	17.1	14.5
5	45.0	4.6	3.9
6	80.0	1.6	.9
7	100.0	.0	.0

Class 8 : ENTERTAINMENT AND RECREATION

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	77.9	35.8
3	5.0	51.1	37.9
4	20.0	14.8	12.2
5	45.0	2.7	1.9
6	80.0	1.1	.6
7	100.0	.0	.0

Class 9 : LARGE PLACES OF FABRICATION AND ASSEMBLY

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	79.7	35.2
3	5.0	57.7	41.0
4	20.0	8.9	9.4
5	45.0	1.9	1.1
6	80.0	.8	.3
7	100.0	.0	.0

Class 10 : HIGH TECHNOLOGY

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	88.8	11.0
3	5.0	16.8	5.0
4	20.0	2.7	1.4
5	45.0	1.5	1.0
6	80.0	1.3	.5
7	100.0	.0	.0

Class 11 : GENERAL SERVICES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	70.4	39.6
3	5.0	36.9	36.3
4	20.0	6.6	6.6
5	45.0	1.5	.9
6	80.0	.8	.4
7	100.0	.0	.0

Class 12 : EMERGENCY RESPONSE SERVICES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	77.6	38.3
3	5.0	54.2	38.7
4	20.0	9.0	6.3
5	45.0	3.0	2.4
6	80.0	1.8	2.2
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 13 : SCHOOLS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	67.4	39.0
3	5.0	31.2	30.2
4	20.0	7.1	7.5
5	45.0	1.8	1.1
6	80.0	.8	.2
7	100.0	.0	.0

Class 14 : TRANSMISSION LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	73.0	15.6
3	5.0	34.1	.3
4	20.0	10.2	3.8
5	45.0	3.5	.4
6	80.0	2.3	.4
7	100.0	.0	.0

Class 15 : DISTRIBUTION STORAGE TANKS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	73.4	34.4
3	5.0	17.5	6.9
4	20.0	3.9	1.0
5	45.0	2.1	.6
6	80.0	1.0	.1
7	100.0	.0	.0

Class 16 : HIGHWAY SYSTEM, MAJOR BRIDGES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	90.3	16.8
3	5.0	59.0	34.1
4	20.0	3.9	3.8
5	45.0	.8	.3
6	80.0	.3	.1
7	100.0	.0	.0

Class 17 : HIGHWAY SYSTEM, TUNNELS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	97.2	5.3
3	5.0	63.6	31.5
4	20.0	5.3	3.0
5	45.0	.9	.2
6	80.0	.3	.1
7	100.0	.0	.0

Class 18 : HIGHWAY SYSTEM, CONVENTIONAL BRIDGES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	58.1	34.8
4	20.0	6.5	4.4
5	45.0	1.2	.4
6	80.0	.4	.1
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 19 : HIGHWAY SYSTEM, FREEWAYS AND CONVENTIONAL HIGHWAYS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	64.6	30.8
4	20.0	14.8	9.8
5	45.0	4.4	3.6
6	80.0	2.7	2.5
7	100.0	.0	.0

Class 20 : RAILWAY SYSTEM, RAILWAY BRIDGES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	94.7	9.9
3	5.0	54.2	30.8
4	20.0	19.1	21.7
5	45.0	1.9	.8
6	80.0	.9	.5
7	100.0	.0	.0

Class 21 : RAILWAY SYSTEM, RAILWAY TUNNELS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	98.7	3.8
3	5.0	50.8	30.8
4	20.0	7.2	4.3
5	45.0	2.3	2.3
6	80.0	.6	.3
7	100.0	.0	.0

Class 22 : RAILWAY SYSTEM, RAILWAYS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	93.8	24.2
3	5.0	48.6	30.2
4	20.0	9.5	3.9
5	45.0	3.4	1.8
6	80.0	1.4	1.4
7	100.0	.0	.0

Class 23 : AIR TRANSPORTATION, TERMINALS, TOWERS, AND OTHER BUILDINGS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	29.6	15.4
4	20.0	5.0	4.0
5	45.0	1.4	.7
6	80.0	.7	.3
7	100.0	.0	.0

Class 24 : AIR TRANSPORTATION, RUNWAYS AND TAXIWAYS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	40.4	4.2
4	20.0	5.4	3.3
5	45.0	1.9	1.0
6	80.0	.6	.1
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 25 : WATERFRONT, PORTS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	87.1	13.3
3	5.0	33.7	19.8
4	20.0	5.2	.8
5	45.0	1.6	.4
6	80.0	.7	.1
7	100.0	.0	.0

Class 26 : WATERFRONT, CARGO HANDLING EQUIPMENT

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	87.5	27.1
3	5.0	32.3	23.7
4	20.0	6.7	3.6
5	45.0	2.0	.7
6	80.0	.8	.2
7	100.0	.0	.0

Class 27 : ELECTRICITY, GENERATING FACILITIES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	94.7	17.8
3	5.0	45.3	33.5
4	20.0	5.0	4.2
5	45.0	.9	.6
6	80.0	.3	.1
7	100.0	.0	.0

Class 28 : ELECTRICITY, TRANSMISSION LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	74.1	34.2
4	20.0	39.0	39.1
5	45.0	25.8	38.3
6	80.0	24.5	39.0
7	100.0	.0	.0

Class 29 : ELECTRICITY, TRANSMISSION SUBSTATIONS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	92.3	26.3
3	5.0	87.5	26.8
4	20.0	27.7	18.2
5	45.0	12.8	16.0
6	80.0	2.4	2.0
7	100.0	.0	.0

Class 30 : ELECTRICITY, DISTRIBUTION LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	72.0	19.5
4	20.0	35.8	33.7
5	45.0	7.5	6.8
6	80.0	2.7	1.6
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 31 : ELECTRICITY, DISTRIBUTION SUBSTATIONS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	72.1	20.8
4	20.0	17.9	11.1
5	45.0	4.5	2.0
6	80.0	2.0	1.3
7	100.0	.0	.0

Class 32 : WATER SUPPLY, TRANSMISSION AQUEDUCTS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	99.9	.6
3	5.0	69.3	27.7
4	20.0	20.8	16.4
5	45.0	7.5	5.1
6	80.0	4.0	3.1
7	100.0	.0	.0

Class 33 : WATER SUPPLY, PUMPING STATIONS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	80.9	36.0
3	5.0	59.1	36.5
4	20.0	17.0	10.8
5	45.0	6.5	5.4
6	80.0	3.6	3.6
7	100.0	.0	.0

Class 34 : WATER SUPPLY, STORAGE RESERVOIRS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	75.4	34.2
3	5.0	46.8	41.7
4	20.0	8.2	4.7
5	45.0	2.2	1.2
6	80.0	.8	.6
7	100.0	.0	.0

Class 35 : WATER SUPPLY, TREATMENT PLANTS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	85.5	34.5
3	5.0	61.5	37.5
4	20.0	8.0	4.0
5	45.0	2.3	1.1
6	80.0	.9	.5
7	100.0	.0	.0

Class 36 : WATER SUPPLY, TERMINAL RESERVOIRS/STORAGE FACILITIES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	97.2	9.3
3	5.0	56.2	36.0
4	20.0	15.5	17.0
5	45.0	4.6	3.4
6	80.0	1.4	.4
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 37 : SANITARY SEWER, EFFLUENT LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	87.1	22.6
3	5.0	70.5	32.8
4	20.0	15.2	7.6
5	45.0	7.4	6.6
6	80.0	3.9	4.1
7	100.0	.0	.0

Class 38 : SANITARY SEWER, BOOSTER PUMPING STATIONS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	77.4	38.1
3	5.0	53.9	42.1
4	20.0	14.9	11.3
5	45.0	6.2	5.3
6	80.0	11.3	17.0
7	100.0	.0	.0

Class 39 : SANITARY SEWER, TREATMENT PLANTS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	72.7	34.0
3	5.0	53.6	39.7
4	20.0	9.0	4.7
5	45.0	2.6	1.3
6	80.0	.7	.2
7	100.0	.0	.0

Class 40 : NATURAL GAS, TRANSMISSION LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	89.2	17.3
4	20.0	45.0	32.5
5	45.0	31.0	40.0
6	80.0	27.9	41.7
7	100.0	.0	.0

Class 41 : NATURAL GAS, LOW PRESSURE HOLDERS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	99.8	.8
3	5.0	64.3	28.8
4	20.0	19.6	16.7
5	45.0	3.7	4.1
6	80.0	2.2	2.8
7	100.0	.0	.0

Class 42 : NATURAL GAS, COMPRESSOR STATIONS, PLANTS, TERMINALS, AND STORAGE FACILITIES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	84.0	20.7
3	5.0	60.4	36.4
4	20.0	14.0	5.1
5	45.0	4.5	1.2
6	80.0	1.7	.3
7	100.0	.0	.0

TABLE 4.7 (Continued)

Class 43 : NATURAL GAS, DISTRIBUTION FEEDER LINES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	99.4	1.3
3	5.0	77.9	31.7
4	20.0	34.7	31.5
5	45.0	21.3	22.1
6	80.0	12.5	15.5
7	100.0	.0	.0

Class 44 : TELEPHONE AND TELEGRAPH, REGIONAL SWITCHING OFFICES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	86.3	29.0
3	5.0	62.6	40.2
4	20.0	40.0	37.9
5	45.0	11.4	14.3
6	80.0	4.9	5.0
7	100.0	.0	.0

Class 45 : TELEPHONE AND TELEGRAPH, INTERREGIONAL SWITCHING OFFICES

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	100.0	.0
3	5.0	82.9	19.1
4	20.0	43.8	34.0
5	45.0	9.3	6.7
6	80.0	3.5	1.9
7	100.0	.0	.0

Class 46 : BROADCAST STATIONS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	59.8	42.7
3	5.0	43.5	40.0
4	20.0	25.9	41.5
5	45.0	10.0	16.7
6	80.0	2.7	3.3
7	100.0	.0	.0

Class 47 : TRANSMISSION TOWERS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	99.6	1.1
3	5.0	78.9	33.6
4	20.0	30.3	30.7
5	45.0	9.9	8.7
6	80.0	7.2	8.4
7	100.0	.0	.0

Class 48 : DAMS

DAMAGE STATE	CDF	FUNC. AT THIRD DAY Mean	St Dv
1	.0	100.0	.0
2	.5	74.5	31.1
3	5.0	51.5	40.9
4	20.0	20.2	27.5
5	45.0	3.3	3.3
6	80.0	.7	.4
7	100.0	.0	.0

Many assumptions are inherent in these estimates of functionality. Principal among them is that loss of functionality and rate of recovery are independent of the time of year and the particular location of the components (i.e., near or far from main transportation arteries). It is also assumed that California loss of functionality data are suitable for use in Boston. These parameters have been considered to be secondary because the amount of uncertainty in these functions is substantial. Attempting to account for these and other parameters is not practicable or warranted. Given the DPM of a component, the intensity of shaking (MMI), and the 3-day functionality function (F_{lj}), the best estimate for the 3-day functionality of the component can be calculated as follows:

$$F_{Dikl} = \sum_{j=1}^{7} DPM_{ijk} F_{lj} \tag{4.7}$$

where:

F_{Dikl} = 3-day functionality of social function class l due to direct damage for structure class i and MMI k

DPM_{ijk} = DPM for structure class i, damage state j, and MMI k

F_{lj} = 3-day functionality of social function class l and damage state j

Equation 4.7 is applicable to main and distribution functions. The loss of functionality of service components is primarily dependent on the facility that the lifeline connects to and can only be estimated on a site-specific basis. This is the reason why functionality of service components is addressed in this study. It should also be noted that loss of functionality of a given service component affects a relatively small number of facilities and is often much easier to correct.

4.6.2 Interdependence of Main and Distribution Components in a Lifeline. The loss of service from a lifeline due to loss of functionality of main or distribution components varies from one lifeline to another. As an example, the loss of electric power from all main components will shut down the electric system, even if the distribution system is fully operational. On the other hand, an interruption of main water supply will not totally shut down the water utility for some time because of the water reserves in the distribution reservoirs and pipes.

Factors of dependence of lifelines on main components 72 hours after the earthquake, developed for this study on the basis of expert opinion, are given in Table 4.8. As an example, a beta factor of 0.1 for water means that the water utility will lose only 10% of its service if the main system is totally lost but the distribution system is fully functional. Conversely, a beta factor of 1.0 for radio and television means that 100% of the service will be lost if the main system is lost, even if the distribution system is fully operational. The beta factors can be used to calculate the 3-day functionality of a lifeline, given the components of F_{Di} from Equation 4.7, as follows:

$$F_i = F_{Di}[\beta_i F_{mi} + (1 - \beta_i)] \tag{4.8}$$

$$F_{Di} = \frac{1}{dd} \sum_{k=1}^{dd} F_{Dik}$$

$$F_{mi} = \frac{1}{mm} \sum_{k=1}^{mm} F_{mik}$$

TABLE 4.8

FACTORS OF INTERDEPENDENCE BETWEEN AND WITHIN LIFELINES

Lifeline	Alpha (α)	Beta (β)
Water	0.7	0.1
Sanitary Sewer	0.9	0.6
Electricity	0.9	1.0
Natural Gas	1.0	1.0
Petroleum	0.8	0.1
Highways	0.3	0.4
Railways	0.9	1.0
Air Transport	0.9	1.0
Sea Transport	0.9	1.0
Telephone and Telegraph	0.2	0.6
Radio and Television	1.0	1.0

$$F_{Dik} = \frac{1}{n} \sum_{j=1}^{n} F_{Dijk}$$

$$F_{mik} = \frac{1}{n} \sum_{j=1}^{n} F_{mijk}$$

where:

F_i = 3-day functionality of lifeline i due to damage to main and distribution components of the lifeline

F_{Di} = 3-day functionality of the distribution system of the lifeline

F_{mi} = 3-day functionality of the main system of the lifeline

β_i = beta factor from Table 4.8 for lifeline i

F_{Dik} = combined 3-day functionality of the distribution system social function class k and structure class i

F_{mik} = combined 3-day functionality of the main system social function class k and structure class i

F_{Dijk} = 3-day functionality of distribution component (social function class) k, structure class i, and MMI j using Equation 4.7

F_{Dk} = 3-day functionality of main component (social function class) k, Structure class i, and MMI j using Equation 4.7

mm = total number of main components

dd = total number of distribution components

n = total number of MMIs considered in the system

Equation 4.8 assumes that the components within the main system and within the distribution system are all in parallel. This gives an average estimate of loss of functionality since some of these components are in fact parallel while others are in series.

4.6.3 Interdependence of Lifelines. The level of recovery of a lifeline in 72 hours after the earthquake may be dependent on the condition of other lifelines. Clearly, recovery from damage to water system components will require the accessibility of electricity, telephones, and transportation. Thus, if these lifelines are themselves down partially or fully, recovering the functionality of the water system will be set back, leading to a 3-day functionality lower than that calculated from Equation 4.8.

The effects of this interdependence of lifelines on each other have been addressed in this study by establishing two factors (alpha and I). Factor alpha, given in Table 4.8, gives the dependence of a lifeline on all other lifelines. Thus, an alpha of 1.0 for radio and television means that this lifeline is totally dependent on all other lifelines. Accordingly, if all other lifelines were shut off, radio and television would also shut down, even if their system suffered no damage. On the other hand, an alpha of 0.2 for telephone and telegraph means that this lifeline is 80% stand-alone.

Factor I, given in Table 4.9, gives the interdependence of each lifeline with other individual lifelines. Thus, the table shows that natural gas lifelines are assumed to depend 59% on electricity, 35% on highways (for access needed for recovery), and 6% on telephone and telegraph (for communications during recovery). The effects of interdependence of lifelines can be calculated as follows:

TABLE 4.9

IMPORTANCE FACTORS FOR LIFELINES

Lifeline	I, by Lifeline										
	Water Supp.	San. Sewer	Elec.	Nat. Gas	Petro-leum	High-ways	Rail-ways	Air Trans	Sea Trans	Tel& Tel	Radio TV
Water	0.00	0.00	0.62	0.00	0.00	0.25	0.00	0.00	0.00	0.13	0.00
Sanitary Sewer	0.47	0.00	0.38	0.00	0.00	0.10	0.00	0.00	0.00	0.05	0.00
Electricity	0.05	0.05	0.00	0.23	0.22	0.22	0.18	0.00	0.00	0.05	0.00
Natural Gas	0.00	0.00	0.59	0.00	0.00	0.35	0.00	0.00	0.00	0.06	0.00
Petroleum	0.00	0.00	0.23	0.00	0.00	0.31	0.00	0.00	0.38	0.08	0.00
Highways	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Railways	0.00	0.00	0.47	0.00	0.48	0.00	0.00	0.00	0.00	0.05	0.00
Air Transport	0.10	0.10	0.16	0.00	0.32	0.16	0.08	0.00	0.00	0.08	0.00
Sea Transport	0.11	0.11	0.27	0.00	0.06	0.22	0.17	0.00	0.00	0.06	0.00
Telephone and Telegraph	0.13	0.13	0.13	0.00	0.00	0.61	0.00	0.00	0.00	0.00	0.00
Radio and Television	0.08	0.08	0.38	0.00	0.00	0.15	0.00	0.00	0.00	0.31	0.00

$$F_{Ti} = F_i \left\{ 1.0 + \alpha_i \left[\sum_{j=1}^{11} (F_j)(I_{ij}) - 1 \right] \right\} \quad (4.9)$$

where:

F_{Ti}	=	Total 3-day functionality of lifeline i
F_i	=	3-day functionality for lifeline i calculated from Equation 4.8
α	=	Alpha for lifeline i from Table 4.8
F_j	=	3-day functionality of lifeline j from Equation 4.8
I_{ij}	=	I for lifeline i and lifeline j from Table 4.9

4.7 Loss of Functionality of Facilities

The functionality of facilities is a function of the direct damage to the facility and the availability of lifeline services. This study has assumed that facilities do not depend on each other for their function. This is true in most cases (e.g., there is no dependence between parking services and educational services). However, in other cases, there is some dependence that has been ignored (e.g., flood control may depend on governmental services).

The methodology for calculating 3-day functionality of facilities is parallel to that discussed for lifelines in Section 4.6. Alpha and I factors for facilities are given in Table 4.10. Beta factors are not relevant for calculating functionality of facilities. The total 3-day functionality of a facility can be calculated to be:

TABLE 4.10

ALPHA AND IMPORTANCE FACTORS FOR FACILITIES

		I, by Lifeline										
Facility	Alpha	Water Supp.	San. Sewer	Elec.	Nat. Gas	Petro-leum	High-ways	Rail-ways	Air Trans	Sea Trans	Tel& Tel	Radio TV
Permanent Housing	0.4	0.35	0.29	0.14	0.07	0.07	0.04	0.00	0.00	0.00	0.04	0.00
Temporary Lodging	1.0	0.22	0.22	0.13	0.09	0.00	0.09	0.07	0.09	0.00	0.09	0.00
Group, Institutional Housing	0.8	0.27	0.27	0.17	0.11	0.00	0.06	0.06	0.00	0.00	0.06	0.00
Prof & Tech Business Services	0.9	0.19	0.19	0.19	0.08	0.00	0.09	0.09	0.02	0.00	0.15	0.00
Health Care	0.9	0.18	0.18	0.18	0.18	0.00	0.14	0.00	0.00	0.00	0.14	0.00
Parking	0.2	0.00	0.00	0.44	0.00	0.00	0.56	0.00	0.00	0.00	0.00	0.00
General Government Services	1.0	0.19	0.19	0.19	0.08	0.00	0.10	0.10	0.00	0.00	0.15	0.00
Emergency Response Services	1.0	0.10	0.10	0.10	0.04	0.00	0.21	0.05	0.08	0.00	0.21	0.10
Education	1.0	0.27	0.27	0.17	0.06	0.03	0.11	0.06	0.00	0.00	0.03	0.00
Flood Control	0.0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

$$F_{TFil} = F_{Dil}\left\{1.0 + \alpha_i\left[\sum_{j=1}^{11} (F_{Tj})(I_{ij}) - 1\right]\right\} \qquad (4.10)$$

$$F_{Dil} = \frac{1}{n} \sum_{k=1}^{n} F_{Dikl}$$

where:

F_{TFil} = total 3-day functionality of facility i with social function class l

F_{Dil} = 3-day functionality of facility i, social function class l, due to direct damage

F_{Dikl} = 3-day functionality of facility i, MMI k, and social function class l due to direct damage (from Equation 4.7)

α_i = alpha for facility i from Table 4.9

F_{Tj} = total 3-day functionality of lifeline j from Equation 4.9

I_{ij} = I for facility i and lifeline j from Table 4.9

4.8 Summary of Methodology to Calculate 3-Day Functionality of Lifelines and Facilities

The preceding discussion clearly demonstrates that many parameters interact in a complex fashion to determine whether society will regain full functionality of its critical facilities and lifelines quickly or be confronted with a worst-case situation. There are no established methodologies to estimate loss of functionality, and the one proposed in this study has not been previously tested. The in-

tention of the study is that these be the best estimates of the loss of functionality, but it is recognized that there will be significant uncertainty in the results.

Recent destructive earthquakes in the 1985 Mexico City and the Loma Prieta earthquake of October 17, 1989 are good examples of substantial ingenuity and creativity on the part of the populace and public agencies of all sorts to find alternatives to disabled, or impaired emergency facilities, to pull through the aftermath of the earthquake. However, the 1988 Armenian earthquake, and the process of long term rebuilding of Mexico City are examples of how it is possible that circumstances may reduce functionality to be lower than would have been expected. The point of all this is that models of functionality that correlate earthquake damage to functionality neglect human and socio-political factors that may be as significant, and sometimes more so, than the physical damage to the facility. These human and socio-political factors add significant uncertainty in any prediction of the post earthquake functionality of facilities. It is unquestionable that emergency planning, and preparing society for its aftermath, as is now done in Japan, will have a telling impact on the ability to respond to an earthquake.

Following is a summary of the way that the equations in Sections 4.6 and 4.7 have been used in calculating 3-day functionality of lifelines and facilities in this study:

a. The 3-day functionality of all lifeline components and facilities due to direct earthquake damage is calculated using Equation 4.7.

b. All the main components of a given lifeline in the whole study area are used to calculate the 3-day functionality of the main system (F_m) of each lifeline as given in Equation 4.8.

c. All the distribution components of a given lifeline in each of the nine zones are used to calculate the 3-day functionality of the distribution system (F_D) in that zone, as given in Equation 4.8.

d. The value of F_m for the whole area and that of F_D for a zone are used to calculate the 3-day functionality of a lifeline in given zone, using Equation 4.8.

e. The total 3-day functionality of a given lifeline (F_T) in each of the zones is calculated using the results of Step d.

f. The 3-day functionality of a facility (F_{Tf}) is calculated using the value of F_D from Step a and the values of F_T from Step e for the zone in which the facility is located.

4.9 Estimating Deaths and Injuries

Deaths and injuries resulting from a postulated earthquake in the metropolitan Boston area are assumed in this study to be primarily due to the failure of man-made structures. Some deaths and injuries during past earthquakes have been the result of other earthquake-induced phenomena (e.g., tsunamis and slope failures), but these are assumed not to be significant in the Boston area. There is less information on deaths and injuries during past earthquakes than on building damage. Official reports of deaths following earthquakes are rarely accurate. For example, about 300 deaths were reported in connection with the 1906 San Francisco earthquake, and this number was accepted and used in earthquake engineering for 80 years. However, recent, very detailed research has verified that more than 2,000 persons died in that earthquake. Injuries have also been reported in a very inconsistent manner. Injuries leading to death may be reported as injuries or deaths or both, and there is still no recognized standard to differentiate between "serious injury" and "injury." Emotional distress cases are rarely reported, even those that might require medical attention later.

It is also difficult to develop analytical models to predict deaths and injuries. People are highly mobile and are capable of taking actions during an earthquake that may significantly decrease or increase the potential for death or injury to themselves. There have been cases of dramatic building failures during earthquakes with relatively low incidence of deaths and injuries, whereas other deaths and injuries recorded during earthquakes have been the result of negligent behavior.

There are other factors that may also have significant effect on the actual number of deaths and injuries during an earthquake. The collapse of the Cypress structure in Oakland during the 1989 Loma Prieta earthquake is a good example of this. Early estimates of 250 deaths in that structure were based on the number of cars expected to be at that stretch of highway at 5.00 PM. It is reasonable that the estimates could have been higher if one postulated the possibility that a couple of fully loaded commuter buses were also in that stretch of highway at that time. However, the actual deaths were less than 40. It is difficult to state conclusively the reasons for why the highway had such few cars on it at that time. The most commonly stated reason is that the Baseball World Series being played in San Francisco at that time had a major impact on this fortunate traffic pattern at the Cypress structure at the time of this earthquake. This example shows vividly how much variability there can be between best estimates of death and injuries, and the actual numbers after an earthquake.

This makes it difficult to estimate deaths and injuries during an earthquake. Nevertheless, Anagnostopoulos and Whitman [6] and others have used data from previous earthquakes to establish estimates of deaths and injuries as a function of structure type and extent of damage. It is clear that the estimates of deaths and injuries are a function of the time of day as well as the level of damage to structures. The population density of different types of buildings

changes dramatically between day and night hours. Furthermore, during the night, large sectors of the population are asleep and relatively immobile, which may render them more or less vulnerable, depending on whether they reside in relatively safe wood frame buildings or more fragile unreinforced masonry buildings.

In this study, matrices that correlate building damage states with deaths, major injuries, and minor injuries have been prepared. A review of the literature concerning reported deaths and injuries in previous earthquakes concluded that the matrices proposed in ATC-13, shown in Table 4.11, are reasonable for use in this study. The estimates of casualties for a given classification of buildings are easily calculated from these matrices, estimates of direct damage to the given classification of buildings, and the associated occupancy in those buildings at the time of the earthquake.

The data given in Table 4.11 can be used directly to calculate deaths and injuries if we have the total number of people in each building in the study area at the time of the earthquake. However, it is computationally practical for a study such as this to identify only the total number of people in a whole social function class (e.g., permanent housing). Since the individual buildings of a social function class are made of different structure classifications and are distributed over the whole study area (thus subjected to different intensities of shaking), it is necessary to introduce a new concept of a weighted damage probability matrix (WDPM), which is defined as follows:

$$(WDPM_{jk})_{yx} = \sum_{i=1}^{n} Pct_i * DPM_{ijk} \qquad (4.11)$$

where:

- x - cell number
- y - social function class (a combination of n different engineering structure classes with corresponding percentage [Pct_i] and DPM_{ijk})
- Pct_i - percentage of population in structure class i
- DPM_{ijk} - DPM for structure class i, MMI j, and damage state k
- $WDPM_{jk}$ - weighted DPM for MMI j and damage state k

The WDPM, the data given in Table 4.11, and the number of people in various social function classes can be used to calculate the total number of deaths, major injuries, and minor injuries as follows:

$$C_{ayx} = \sum_{j=1}^{n} P_{jyx} * MCF_{jayx} \tag{4.12}$$

where:

$$MCF_{jayx} = \sum_{k=1}^{7} (WDPM_{jk})_{yx} * C_{kayx}$$

- C_{ayx} - total casualties of type a, social function class y, in cell x
- P_{jyx} - population of social function class y in cell x for MMI j
- n - total number of MMIs in cell x

TABLE 4.11

INJURY AND DEATH RATES

Damage State	**CDF(S) (%)**	**Fraction Injured**		**Fraction Dead**
		Minor	**Serious**	
1	0.0	0	0	0
2	0.5	3/100,000	1/250,000	1/1,000,000
3	5.0	3/10,000	1/25,000	1/100,000
4	20.0	3/1,000	1/2,500	1/10,000
5	45.0	3/100	1/250	1/1,000
6	80.0	3/10	1/25	1/100
7	100.0	2/5	2/5	1/5

Note: For light steel construction and wood-frame construction, multiply all numerators by 0.1.

5. EARTHQUAKE LOSS EVALUATION

5.1 Damage and 72-Hour Functionality Evaluation

This section gives a summary of the damage and functionality evaluation for the study area based on the seismic hazard for the postulated earthquake described in Chapter 2, the inventory of facilities given in Chapter 3, and the loss evaluation procedure described in Chapter 4. Damage to discrete facilities, e.g., buildings, is given in dollars, and damage to pipelines is given in breaks per mile. These are consistent with the inventory data given in Chapter 3 and the damage probability matrices (DPMs) given in Chapter 4. The facility functionalities presented here are the functionalities 72 hours after the postulated earthquake strikes.

Damage and 72-hour postearthquake functionality for the entire study area reported here is presented in ten major groupings of facilities as follows:

1. Medical Facilities
2. Transportation Facilities and Systems
3. Gas and Petroleum Fuel Utilities
4. Water and Sewerage Utilities
5. Electric Power Utility
6. Communications Network
7. Emergency Public Facilities
8. Residential Buildings
9. School Buildings
10. Special Facilities

This grouping of facilities is consistent with the inventory data given in Chapter 3.

Damage and 72-hour postearthquake functionality for each type of facility is reported for each of the nine cells whenever permitted by the anonymity criterion. Specifically, individual buildings or facility sites have not been investigated with sufficient detail to constitute site-specific postearthquake damage or functionality evaluations. A criterion of reporting on a minimum of 10 facilities was established to ensure that a specific facility could not be identified. Accordingly, various cell groupings are used for reporting losses for various types of facilities. Damage and functionality were calculated for each cell, however. For lifeline facilities, main components are always reported for Cells 1 through 9, and distribution components are reported for each cell or for groupings as consistent with the anonymity criterion. Table 4.6 gives a listing of the individual lifeline facilities included in the evaluation and distinguishes the main and distribution components.

5.1.1 **Medical Facilities.** Medical facilities included in the study are:

- Hospitals
- Nursing Homes
- Ambulance Service
- Medical Supply Houses
- Blood Banks
- Clinical Labs
- Health Manpower

Table 5.1a gives a summary of the damage and 72-hour postearthquake functionality for each of these types of facilities. Damage factors (damage/replacement value) for all facilities vary between a low of 2.1% to a high of 15.1%, which is the range reported for hospitals. These results are consistent with the distribution of the seismic hazards for the area. Cells 1 through 3, for which a damage factor of 2.1% is reported, consist mostly of seismic hazard zones 1 and 2

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(MMI V and VI). The 15.1% damage factor reported for Cells 5 and 7 are mostly seismic hazard zone 3 (MMI VII).

The range of 72-hour postearthquake functionality of the medical facilities varies from a low of 14% to a high of 26%. It is law in Massachusetts that all hospitals and Level I and Level II nursing homes (see Table 3.4b) have emergency backup power. The functionality evaluations reported do not consider this, however, because of the high seismic vulnerability of these types of equipment and thus the potential for losing backup power. If backup power is available, the functionalities of those facilities will increase slightly.

For ambulance services, the 72-hour postearthquake functionality determined is 18%. This is based on damage to the garages, and presumably more than 18% of the available ambulances would be available for emergency response.

Although the level of damage determined is not severe, the functionality of the various medical facilities is low. On this basis, the ability of the available services to respond to the immediate postearthquake needs is poor.

5.1.2 **Transportation Facilities and Systems.** Following is a list of the major systems included in transportation for this study:

- Highway System
- Airport Facilities
- Water Port Facilities
- Public Transportation System

A detailed description of the various facilities included in each of these systems is given in Section 3.5.

Table 5.1b gives the estimated damage and 72-hour postearthquake functionality for the main and distribution components of each of the transportation systems. Specific items included as main and as distribution components are detailed in Table 4.6. There are no distribution components for water port facilities. Cell aggregations were made for the distribution components of the other transportation systems to maintain anonymity.

The damage factor for the highway system ranges from a low of 1.0% to a high of 6.6%. The 72-hour postearthquake functionality ranges from 61% to 100% for the various cells.

The damage factor range for airport facilities varies from 3.7% to 4.5%, and the 72-hour postearthquake functionality is 62%. On this basis, it is tentatively expected that the airports will be functional following the postulated earthquake. Site-specific evaluations of the soil conditions at runways and taxiways are needed to verify this expectation, however.

The damage factor for water port facilities is 5.2%, and the 72-hour postearthquake functionality is 47%. Water port facilities are expected to be usable after the postulated earthquake, but there will be impairments to function.

For the public transportation system, the damage is in the range of 5.4% to 8.9%, and the 72-hour postearthquake functionality ranges from 61% to 65%.

5.1.3 **Gas and Petroleum Fuel Utilities.** Estimated damage and 72-hour postearthquake functionality for the natural gas and petroleum fuel facilities are given in Table 5.1c.

The damage factor for the main natural gas components is 4.1%, and the 72-hour functionality is 89%. For natural gas distribution

components, the damage factor range is from 1.6% to 12.1%. Functionality for natural gas distribution components is high, ranging from 84% to 95%.

The evaluation considered all petroleum fuel facilities to be main components, and they are so reported in Table 5.1c. The damage factor for petroleum fuel is a low 3.1%. The 72-hour postearthquake functionality is 47%. Although the 47% functionality may at first appear inconsistent with the low 3.1% damage factor, it is not. A very inexpensive pipe break at a storage tank connection can render the storage tank useless 72 hours after the earthquake. A failure of this nature could pose a significant environmental hazard when the postulated earthquake occurs.

5.1.4 Water and Sewerage Utilities. Damage and 72-hour postearthquake functionality of the water and sewer systems in the study area are given in Table 5.1d.

The damage factor for the water system main components (aqueducts, tunnels, reservoirs, and treatment plants) is 1.0%, and the 72-hour postearthquake functionality is 81%. The damage factor for the distribution components (storage facilities, pressure control facilities, and distribution pipelines) is in the range of 1.0% to 2.4%, and the 72-hour postearthquake functionality ranges from 81% to 98%. A total of 29 pipe breaks were determined from this evaluation. Note that no pipe breaks are reported for the main water components because aqueducts and tunnels were regarded as main water conduits for this study, and these are treated as discrete (but long) facilities. On the basis of this evaluation, water service to the study area is not expected to be severely impaired by the postulated earthquake.

For the sewer system main components (outfalls, treatment plants, and tunnels), the damage factor is 2.0%, and the 72-hour postearthquake functionality is 65%. For the distribution components (headworks,

pumping stations, and interceptor/collector lines), the damage factor ranges from 0.2% to 3.3%, and the 72-hour postearthquake functionality ranges from 72% to 89%. Forty-eight breaks were determined for the 220 miles of distribution pipe included in this evaluation. On the basis of this evaluation, it is expected that the sewer system will be adequately functional to serve the inhabitants of the study area following the postulated earthquake, and no major health hazard is expected.

5.1.5 Electric Power Utility. Damage and 72-hour postearthquake functionality of the electric power system are given in Table 5.1e. The damage factor for the main components (generating stations, major substations, and major transmission lines) is 5.0%, and the 72-hour postearthquake functionality is 74%. The damage factor for the distribution components (distribution substations) varies from 1.6% to 4.2%, and the 72-hour functionality varies from 76 to 84%.

Considering the low damage factors determined in this evaluation and the redundancy commonly built into electrical systems, it is expected that electrical power will be available to serve the majority of the facilities in the study area following the postulated earthquake.

5.1.6 Communications Network. Systems included in the evaluation of the communications network in the study area are:

- Telephone
- Radio
- Television

Estimated damage and 72-hour postearthquake functionality for these facilities are given in Table 5.1f. All components of the radio and television and telephone systems considered are main components and are reported in Table 5.1f for the aggregation of Study Cells 1 through 9.

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The damage factor for the telephone system is low (4.6%), and the functionality is high (74%). Conversely, for radio and television, the damage factor is 9.0% and the 72-hour postearthquake functionality is 35%. The damage factor variation results from the fact that a high percentage of the radio and television facilities are located in seismic hazard zone 3 (MMI VII) whereas a high percentage of telephone facilities are located in hazard zone 1 (MMI V). The high functionality for telephone results from a combination of both the low damage determined and the high functionality vector for telephone communications (see Table 4.7, Class 44).

Nearly all of the major radio stations in the study área have emergency backup power. In making the 72-hour functionality evaluation, the availability of backup power was neglected because of the possibility of failure of this equipment. If backup power is functional after the earthquake, the functionality would increase about 10% because of the high dependence of radio and television on electrical power. It is expected that most of those stations with functioning backup power will be able to make Emergency Broadcast Service (EBS) announcements after the postulated earthquake.

5.1.7 Emergency Public Facilities. In connection with this evaluation, emergency public facilities include:

- Police Stations
- Fire Stations
- Civil Defense Emergency Operating Centers
- National Guard Armories

The personnel associated with these facilities are usually the first to respond in a postearthquake disaster situation. Accordingly, these facilities are important in connection with postearthquake public safety in minimizing casualties.

Estimated damage and 72-hour postearthquake functionality for these facilities are given in Table 3.1g. Damage factors for these facilities range from a low of 3.3% to a high of 14.4%. The 72-hour postearthquake functionality for these facilities ranges from 16% to 26%.

All police and fire stations, and a majority of the emergency operating centers, have backup electrical power equipment. None of the National Guard armories has backup power. In performing the functionality evaluation, backup power was ignored, assuming that this equipment might fail as well. If the backup power operates, the functionality would increase a few percent.

For the 72-hour postearthquake functionalities determined in this evaluation, the disaster response effectiveness of the existing emergency public facilities is questionable. Because of the importance of these facilities in the postearthquake environment, site-specific seismic vulnerability studies of these facilities should be conducted.

5.1.8 **Residential Buildings**. Damage and 72-hour postearthquake functionality for residential buildings are given in Table 5.1h. Damage factors in the nine study cells vary from a low of 2.3% to a high of 10.0%. The 72-hour postearthquake functionality of residential buildings ranges from 57% to 62%. The high functionality determined results from a combination of two factors: (1) the low damage factors common to the vast majority of the housing in the study area, which is wood frame, and (2) the low dependence of residential building functionality on lifelines.

Although there are few data presently available for estimating the number of persons rendered homeless because of earthquake damage, it is reasonable to assume that, for buildings damaged about 50%, the home is not usable. The DPMs given in Table 4.5 show probabilities of buildings having 45% as the central damage factor. For this

evaluation, it was assumed that persons in residential buildings experiencing a CDF ≥ 0.45 were homeless. Table 5.1h also gives the number of persons homeless following the postulated earthquake. The total of 25,600 homeless presented in Table 5.1h is one-third of the number calculated using the above-stated criterion. The one-third factor was used to account for buildings damaged less severely than 45%, which are probabilistically included in the CDF of 0.45, and to account for those buildings that are indeed severely damaged but still useful as emergency shelter.

Damage to modern wood frame buildings in seismic hazard zone 1 (MMI = V) is expected to be negligible. At the other extreme, heavy-timber masonry bearing-wall buildings in seismic hazard zone 3 are expected to be moderately severely damaged, with some partial collapses. Casualties in residential buildings are given in Section 5.2.

5.1.9 Schools. For this evaluation, schools in the study area are distinguished as follows:

- Public K-12
- Private K-12
- Colleges and Universities

Damage and 72-hour postearthquake functionalities for all three school categories are given in Table 5.1i. The damage factor range for all schools is 0.7% to 15.5%. The 72-hour postearthquake functionality varies from a low of 11% to a high of 19%. These low functionality percentages reflect the high dependence of schools on lifelines for full functionality. Although school buildings may not be usable as places of education, it is expected that many of these buildings will be usable as emergency shelters after the postulated earthquake.

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Because the majority of the schools in the study area are old, and are frequently constructed of masonry materials, some of these buildings are expected to be severely damaged during the postulated earthquake. Casualties in schools are given in Section 5.2.

5.1.10 Special Facilities. Included in this study under the category of special facilities are:

- Dams
- Tall Buildings

Damage and 72-hour postearthquake functionality for dams and tall buildings are given in Table 5.1j. The damage factor for dams varies from a low of 0.4% to 1.5%. No dam failures are expected. The 72-hour postearthquake functionality calculated for dams varies from 69% to 72%. On the basis of the low damage, and judgment, it is expected that the functionality of dams will be in the range of 95% to 100% 72 hours after the postulated earthquake. Dams are not expected to be damaged consequentially, and no failures causing inundation are expected.

The estimated damage factor for tall buildings is 10.3%, and the 72-hour postearthquake functionality is 27%. This high damage factor results primarily because all of these buildings are located in seismic hazard zone 3. No collapses of tall buildings are expected. Functional disruption and moderate damage and casualties in these building are expected.

5.1.11 Summary of Damage and 72-Hour Functionality. Table 3.1k gives a summary of damage, damage factors, and 72-hour postearthquake functionality for each of the ten facility groups discussed above.

For the facilities included in this evaluation, the total damage determined is $4.2 billion. Damage to residential buildings

($2.5 billion) is the largest contributor to the total damage for the postulated earthquake. Damage to school buildings ($1.0 billion) is the next largest contributor and reflects the concentration of colleges and universities in the study area.

The $4.2 billion damage estimated should not be regarded as the total loss for the entire study area because many facilities have not been addressed in this detailed evaluation. Importantly, commercial and industrial facilities and building contents have not been included. These are addressed in Section 5.6, "Financial Loss Summary."

The range of damage factors for all facilities is 0.4% to 15.5%. This damage factor range does not represent upper and lower bounds. For residential buildings, for example, it is fully expected that the postulated earthquake will cause no damage to some buildings while others will be severely damaged. Although the range of damage factors given in Table 5.1k appears reasonable, the factors are regarded as somewhat high. The $2.5 billion damage to residential buildings, when divided by the $54 billion replacement value (see Table 3.1b), yields an overall damage factor of 5%. On the basis of judgment, 2% to 3% seems more appropriate.

The overall 72-hour postearthquake functionality range is from a low of 11% to a high of 100%. For the lifelines, the functionality range is 35% to 100%. For buildings, the functionality range is 11% to 62%. The lowest functionalities determined are for school buildings (11% to 19%) and for emergency public facilities (16% to 26%). Because of the importance of the emergency public facilities in connection with postearthquake emergency response, it appears that site-specific seismic vulnerability studies of these buildings are warranted.

TABLE 5.1a

MEDICAL FACILITIES:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Hospitals	1-3	3,042	0.021	24
Hospitals	4,6	8,614	0.052	16
Hospitals	5,7	52,279	0.151	16
Hospitals	8,9	4,939	0.036	14
Hospitals Total	1-9	68,874		
Clinical Labs	1-3	323	0.066	25
Clinical Labs	4,5	386	0.079	23
Clinical Labs	7	2,385	0.152	18
Clinical Labs	6,8,9	342	0.087	21
Clinical Labs Total	1-9	3,436		
Ambulance Services	1-9	591	0.127	18
Medical Supply Houses	1-9	583	0.108	14
Blood Banks	1-9	660	0.130	17
Nursing Homes	1	1,833	0.056	24
Nursing Homes	2,3	1,105	0.047	26
Nursing Homes	4	1,332	0.068	24
Nursing Homes	5	5,227	0.088	21

TABLE 5.1a (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Nursing Homes	6	4,597	0.075	23
Nursing Homes	7	3,259	0.062	23
Nursing Homes	8	876	0.034	25
Nursing Homes	9	4,092	0.055	22
Nursing Homes Total	1-9	22,321		
Medical Facilities Total	1-9	96,465		

TABLE 5.1b

TRANSPORTATION FACILITIES AND SYSTEMS:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Function-ality (%)
HIGHWAY SYSTEM				
Main Components	1-9	20,788	0.064	67
Distribution Components	1	--	--	--
Distribution Components	2	143	0.061	66
Distribution Components	3	119	0.035	61
Distribution Components	4	*	*	100
Distribution Components	5	454	0.066	61
Distribution Components	6	422	0.059	73
Distribution Components	7	394	0.066	61
Distribution Components	8	24	0.010	61
Distribution Components	9	143	0.038	61
Highway System Total	1-9	22,487		
AIRPORT FACILITIES				
Main Components	1-9	14,826	0.045	62
Distribution Components	1-9	7,246	0.037	62
Airport Facilities Total	1-9	22,072		
WATER PORT FACILITIES	1-9	16,124	0.052	47

TABLE 5.1b (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Function-ality (%)
PUBLIC TRANSPORTATION				
Main Components	1-9	7,317	0.089	62
Distribution Components	1-5	802	0.054	65
Distribution Components	6-9	2,019	0.085	61
Public Transportation Total	1-9	10,138		
Transportation Facilities and Systems Total	1-9	70,821	--	

* Negligible amount

TABLE 5.1c

GAS AND PETROLEUM FUEL UTILITIES:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Number of Breaks	Function-ality (%)
NATURAL GAS					
Main Components	1-9	3,492	0.040	3	89
Distribution Components	1	45	0.041	4	84
Distribution Components	2	10	0.016	1	95
Distribution Components	3	11	0.019	4	95
Distribution Components	4	23	0.023	6	95
Distribution Components	5	140	0.079	6	84
Distribution Components	6	34	0.063	5	84
Distribution Components	7	54	0.039	5	95
Distribution Components	8	110	0.121	2	84
Distribution Components	9	26	0.020	4	95
Natural Gas Total	1-9	3,946		40	

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TABLE 5.1c (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Number of Breaks	Function-ality (%)
PETROLEUM FUEL	1-9	2,296	0.031	--	47
Repair Cost for Breaks		280			
Gas and Petroleum Fuel Utilities Total		6,522			

TABLE 5.1d

WATER AND SEWERAGE UTILITIES:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Number of Breaks	Functionality (%)
WATER SYSTEM					
Main Components	1-9	1,812	0.010	0	81
Distribution Components	1	33	0.007	3	83
Distribution Components	2	21	0.006	1	90
Distribution Components	3	328	0.024	5	83
Distribution Components	4	85	0.022	4	82
Distribution Components	5	5	0.027	5	81
Distribution Components	6	14	0.010	5	81
Distribution Components	7	*	*	3	86
Distribution Components	8	*	*	1	98
Distribution Components	9	*	*	2	98
Water System Total	1-9	2,298		29	
SEWERAGE SYSTEM					
Main Components	1-9	2,938	0.020	3	65

TABLE 5.1d (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Number of Breaks	Function-ality (%)
Distribution Components	1	208	0.016	7	72
Distribution Components	2	10	0.002	1	82
Distribution Components	3	414	0.023	11	76
Distribution Components	4	83	0.024	2	76
Distribution Components	5	42	0.033	7	78
Distribution Components	6	--	--	3	89
Distribution Components	7	--	--	7	89
Distribution Components	8	--	--	2	89
Distribution Components	9	126		5	72
Severage System Total	1-9	3,821		48	
Repair Cost for Breaks		539			
Water and Severage Utilities Total	1-9	6,658			

* Negligible amount

TABLE 5.1e

ELECTRIC POWER UTILITY:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Main Components	1-9	56,386	0.050	74
Distribution Components	1-2	374	0.016	84
Distribution Components	3-4	240	0.024	81
Distribution Components	5-6	309	0.033	83
Distribution Components	7-9	415	0.042	76
Electric Power Utility Total	1-9	57,724		

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TABLE 5.1f

COMMUNICATIONS NETWORK:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Telephone	1-9	6,903	0.046	74
Radio and Television	1-9	7,589	0.090	35
Communications Network Total	1-9	14,492		

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[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]

TABLE 5.1g

EMERGENCY PUBLIC FACILITIES:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Police Stations	1-3	863	0.070	26
Police Stations	4-6	1,794	0.118	21
Police Stations	7-9	1,217	0.107	17
Police Stations Total	1-9	3,874		
Fire Stations	1	778	0.086	23
Fire Stations	2,3	276	0.073	22
Fire Stations	4,6	722	0.074	22
Fire Stations	5	1,459	0.144	19
Fire Stations	7	1,339	0.123	19
Fire Stations	8	*	*	--
Fire Stations	9	199	0.033	16
Fire Stations Total	1-9	4,773		
National Guard Armories	1-9	859	0.142	18

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TABLE 5.1g (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Emergency Operating Centers	1,2,5	125	0.088	23
Emergency Operating Centers	3,4,6-9	106	0.074	20
Emergency Operating Centers Total	1-9	231		
Emergency Public Facilities Total	1-9	9,737		

* Negligible damage

TABLE 5.1h

RESIDENTIAL BUILDINGS

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)	Homeless (persons)
Residences	1	218,653	0.037	60	1,340
Residences	2	99,027	0.023	62	480
Residences	3	149,390	0.033	58	400
Residences	4	187,965	0.030	58	1,360
Residences	5	420,332	0.068	57	5,540
Residences	6	242,930	0.054	59	2,750
Residences	7	624,175	0.100	59	7,780
Residences	8	161,841	0.033	62	1,600
Residences	9	401,969	0.034	59	4,350
Residential Buildings Total	1-9	2,506,282			25,600

TABLE 5.1i

SCHOOL BUILDINGS:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Public K-12	1	12,542	0.080	14
Public K-12	2	6,816	0.063	16
Public K-12	3	6,541	0.078	13
Public K-12	4	11,862	0.081	13
Public K-12	5	37,975	0.136	11
Public K-12	6	12,112	0.086	14
Public K-12	7	27,078	0.130	13
Public K-12	8	862	0.009	19
Public K-12	9	17,979	0.069	13
Public K-12 Total	1-9	133,767		
Private K-12	1	2,818	0.108	14
Private K-12	2	898	0.061	16
Private K-12	3	134	0.017	16
Private K-12	4	6,675	0.116	13
Private K-12	5	11,544	0.155	11
Private K-12	6	3,710	0.079	13
Private K-12	7	10,668	0.137	13
Private K-12	8	316	0.007	19
Private K-12	9	7,383	0.071	13
Private K-12 Total	1-9	44,146		

TABLE 5.11 (Continued)

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Colleges & Univ.	1	*	*	--
Colleges & Univ.	2	*	*	--
Colleges & Univ.	3	*	*	--
Colleges & Univ.	4	91,486	0.079	17
Colleges & Univ.	5	22,870	0.042	14
Colleges & Univ.	6	78,897	0.049	19
Colleges & Univ.	7	534,105	0.103	19
Colleges & Univ.	8	*	*	--
Colleges & Univ.	9	86,414	0.098	18
Colleges & Univ. Total	1-9	813,772	--	
School Buildings Total	1-9	991,685		

* Negligible damage

TABLE 5.1j

SPECIAL FACILITIES: DAMS AND TALL BUILDINGS:

DAMAGE AND 72-HOUR POSTEARTHQUAKE FUNCTIONALITY

Facility	Cell	Damage ($ thousands)	Damage Factor (D/RV)	Functionality (%)
Dams	1-2	11	0.004	72
Dams	3,4,6	46	0.013	71
Dams	5,7-9	38	0.005	69
Dams Total	1-9	95		
Tall Buildings	1-9	389,764	0.103	27

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TABLE 5.1k

SUMMARY OF DAMAGE AND

72-HOUR POSTEARTHQUAKE FUNCTIONALITY EVALUATION

Facility Group	Damage ($ thousands)	Damage Factor Range (D/RV, %)	Functionality Range (%)
Medical Facilities	96,465	2.1 - 15.2	14 - 26
Transportation Facilities and Systems	70,821	1.0 - 8.9	47 - 100
Gas and Petroleum Fuel Utilities	6,242	1.6 - 12.1	47 - 95
Water and Severage Utilities	6,658	0.2 - 3.3	65 - 98
Electric Power Utility	57,724	1.6 - 5.0	74 - 84
Communications Network	14,492	4.6 - 9.0	35 - 74
Emergency Public Facilities	9,737	3.3 - 14.4	16 - 26
Residential Buildings	2,506,282	2.3 - 10.0	57 - 62
School Buildings	991,685	0.7 - 15.5	11 - 19
Special Facilities:			
-- Dams	95	0.4 - 1.3	69 - 72
-- Tall Buildings	389,764	10.3	27
Total	4,149,965		

5.2 Casualties

The scope of this study involves estimating casualties for each of the nine cells of the study area and for three times of day: 2:00 a.m., 2:00 p.m., and 4:30 p.m. The casualties estimated include deaths, major injuries requiring hospitalization, and minor injuries not requiring hospitalization. Casualties due to potential fire have not been included.

As indicated in Section 4.9, the methodology for evaluating casualties involves identifying the numbers of persons for each of these times of day, in various facility social function classifications, engineering classifications, cells, and hazard zones. For this study, four social function categories have been distinguished for making the casualty assessment: residential; commercial and industrial; schools; and freeways, streets, and sidewalks.

It is reasonable to assume that the majority of the population is in residences at 2:00 a.m. At 2:00 p.m., a majority of school-age children are at school, except in the summer months, and the majority of workers are at their place of work. It is more difficult to establish with confidence where the rest of the population (e.g., housewives, retired people, the unemployed, preschool children, and those on vacation from work) are at that hour. At 4:30 p.m., a large portion of the population is either at home (e.g., school children and housewives) or on the way home from work.

The population of the study area for the three times of day considered is not static. In addition, the distribution of the population in the four social function categories established in the nine geographical cells and in their respective engineering classification of structure must be identified.

Table 5.2a gives the number of persons employed in the study area in 1986. Based on a review of additional information from the Massachusetts Department of Employment Security, it was determined that, of the 1.1 million persons employed in the study area, about 200,000 live outside the study area. In addition, the 1986 population data from the Massachusetts Department of Revenue include only residents in place on January 1. In this regard, about 100,000 of the 180,000 college and university students given in Table 3.12b could be added to the residential population to establish a total daytime population. Because it is questionable whether the student population is included in the basic population and because it would cause only a 5% variation, it was neglected in this evaluation.

Given that the total number of workers in the study area is 1.1 million persons and the number of workers from outside the study area is 200,000, the number of resident workers is 900,000. The number of residents in the study area, other than workers and students, is 1,752,000 minus 900,000 resident workers minus 490,000 students = 362,000 persons. In summary, there are 490,000 students, 1,100,000 workers, and 362,000 nonstudent nonworkers in the study area.

The distribution of persons in the four social function/location classifications established for this evaluation is given in Table 5.2b. At 2:00 a.m., the distribution of persons includes about 98% of the study area residents in residential buildings and 5% of the workers in commercial and industrial (CI) buildings. At 2:00 p.m., the nonstudent, nonworker population is distributed as follows: 60% in residential buildings, 35% in commercial, industrial, and institutional buildings, and 5% on sidewalks, streets, freeways, and elevated highways. At 2:00 p.m., the entire school population of 490,000 persons is assumed to be in school buildings, and 95% of the worker population was assumed to be in CI buildings, with the remaining 5% on sidewalks, streets, freeways, and elevated highways. At 4:30 p.m., it was assumed that all the students and 95% of the resi-

dential nonworkers are in a residential building. Further, it was assumed that 30% of the workers were in CI buildings. Finally, it was assumed that 70% of the workers and about 5% of the nonstudent, nonworker residents were in transit (on sidewalks, streets, freeways, or elevated highways).

The geographical (cell) distribution of persons in residences used in calculating casualties for residential building occupancy is the same as that for residential buildings described in Section 3.11. The cell distribution of population for schools is the same as that described in Section 3.12. The cell distribution of population for commercial and industrial buildings and for sidewalks, streets, freeways, and elevated highways was established from aggregating the city and town employee data given in Table 5.2a.

The engineering classifications and cell distributions used for making the casualty evaluations for residential buildings are the same as those described in Section 3.11. Similarly, the engineering classifications of structures used for evaluating school casualties are those described in Section 3.12. The engineering classifications of structures for the commercial and industrial social function classification used for the casualty evaluation is the same as that established for residential buildings, but, excluding low-rise wood frame structures.

Table 5.2c gives the results of the casualty evaluation for schools (K-12 public, K-12 private, and colleges and universities) and total for schools. Table 5.2d gives the results for the residential building evaluation at 2:00 a.m. Table 5.2e shows the results for 1.2 million persons in commercial and industrial buildings at 2:00 p.m. Table 5.2f gives the final estimates of casualties for 2:00 a.m., 2:00 p.m., and 4:30 p.m. Casualties for persons on streets caused by falling debris and for persons on roads and freeways are based on

estimated casualty rates of 100/100,000, 20/100,000, and 5/100,000 for minor injuries, serious injuries, and deaths, respectively.

TABLE 5.2a

DISTRIBUTION OF EMPLOYEES IN STUDY AREA

City	Population* (1986)	No. of Employees** (1986)
Arlington	44,350	8,826
Bedford	12,490	25,733
Belmont	25,020	6,924
Boston	573,600	505,360
Brookline	52,360	18,647
Cambridge	91,260	97,073
Chelsea	25,640	9,152
Dedham	23,810	14,010
Everett	36,330	14,046
Lexington	28,610	18,454
Lynn	78,560	34,998
Malden	53,490	20,001
Marblehead	19,580	4,816
Medford	56,830	18,392
Melrose	28,790	6,123
Milton	25,500	5,393
Nahant	3,940	520
Newton	82,140	48,349
Quincy	82,630	40,250
Revere	43,510	7,930
Salem	38,050	19,776
Saugus	25,860	9,725
Somerville	72,280	19,998
Stoneham	22,550	7,164
Swampscott	13,330	3,015
Wakefield	25,170	11,298
Waltham	57,090	59,796
Watertown	32,890	19,167
Winchester	20,120	6,561
Winthrop	18,640	3,013
Woburn	37,380	35,349
Total	1,751,800	1,099,859

* Source: Massachusetts Department of Revenue
** Source: Massachusetts Department of Employment Security

TABLE 5.2b

POPULATION BASE FOR CASUALTIES EVALUATION

Social Function Class/Location	Time of Day 2:00 a.m.	2:00 p.m.	4:30 p.m.
Residential Buildings	1,720,000	220,000	830,000
Commercial and Industrial	55,000	1,210,000	330,000
Schools	*	490,000	*
Sidewalks, Streets, Freeways, and Elevated Highways	*	40,000	800,000
TOTAL	1,775,000	1,960,000	1,960,000

* Small number; neglected in this evaluation.

TABLE 5.2c

CASUALTIES IN SCHOOLS

Summary of Casualties for Private Schools (2:00 p.m.)

Cell	Minor Injuries	Serious Injuries	Deaths
1	19	3	1
2	6	1	0
3	0	0	0
4	50	7	2
5	82	11	3
6	20	3	1
7	84	11	3
8	1	0	0
9	62	8	2
TOTAL	324	44	11

Summary of Casualties for Public Schools (2:00 p.m.)

Cell	Minor Injuries	Serious Injuries	Deaths
1	88	12	3
2	45	6	2
3	38	5	1
4	88	12	3
5	253	34	9
6	56	8	2
7	220	30	8
8	3	0	0
9	152	21	5
TOTAL	942	128	32

TABLE 5.2c (Continued)

Summary of Casualties for College and Universities (2:00 p.m.)

Cell	Minor Injuries	Serious Injuries	Deaths
1	0	0	0
2	0	0	0
3	0	0	0
4	58	8	2
5	14	2	0
6	29	4	1
7	333	45	11
8	0	0	0
9	53	7	2
TOTAL	487	66	17

Summary of Casualties for Schools (2:00 p.m.)

Cell	Minor Injuries	Serious Injuries	Deaths
1	106	14	4
2	51	7	2
3	38	5	1
4	196	27	7
5	350	47	12
6	105	14	4
7	637	86	22
8	4	1	0
9	266	36	9
TOTAL	1,753	237	60

TABLE 5.2d

CASUALTIES FOR THE ENTIRE STUDY AREA

2:00 a.m.

Cell	Minor Injuries	Serious Injuries	Deaths
1	209	97	7
2	66	45	2
3	76	67	3
4	213	80	7
5	841	245	29
6	423	130	15
7	1,766	381	61
8	242	80	8
9	691	159	23
TOTAL	4,527	1,284	155

2:00 p.m.

Cell	Minor Injuries	Serious Injuries	Deaths
1	511	69	18
2	177	24	6
3	415	55	14
4	654	88	23
5	1,560	211	54
6	944	127	33
7	3,663	494	125
8	545	73	18
9	2,027	273	69
TOTAL	10,496	1,414	360

TABLE 5.2d (Continued)

4:30 p.m.

Cell	Minor Injuries	Serious Injuries	Deaths
1	241	36	9
2	89	13	4
3	182	28	7
4	280	43	11
5	752	106	27
6	487	71	18
7	1,709	242	61
8	333	51	13
9	943	139	35
TOTAL	5,016	729	185

5.3 Review of Losses for Critical Industries

5.3.1 Description of Facilities. For the purpose of this study, critical industries in the metropolitan Boston area are considered to include: (1) high-technology industry (e.g., semiconductor manufacturers, computer producers, data base electronic firms); (2) large computerized banking facilities; (3) large supermarket chains; (4) large employers; (5) large places of assembly (e.g., sports arenas, movie theaters); (6) large rail freight companies; and (7) large freight companies. A general survey of the Boston area indicates that high-technology industries tend to be concentrated near Route 128, and banking industries tend to be centralized in Boston. The other industries tend to be uniformly distributed throughout the study area.

Critical industries in the Boston area occupy a wide variety of building types. High-technology industries, supermarkets, freight companies, and trucking companies tend to be located in one- or two-story buildings. The most common structural system for these buildings consists of nominally reinforced or unreinforced exterior concrete masonry walls, plywood or metal deck roofs and floors, open-web steel roof and floor joists, and steel interior columns. The record of earthquake performance of this type of building has not been good. Earthquake failures have occurred because the exterior walls, which tend to attract seismic forces, are often not well connected to the roofs or floors. Typical damage patterns observed in past earthquakes include failure of roof-to-wall or floor-to-wall connections causing the walls to fall outward and the roofs or floors to fall inward. Buildings housing supermarkets, freight companies, and trucking companies may be especially vulnerable to earthquake damage if one or more walls of these buildings is essentially open for receiving or shipping goods and materials. Buildings with this configuration are particularly vulnerable to earthquake damage because the structural resistance is not symmetrical with respect to

the building's mass, creating additional seismic demands on the structure due to the eccentricity.

When high-technology industries are office and laboratory buildings, these buildings tend to be of moderate height (less than eight stories) and are characterized by large, open floor areas and the extensive use of glazed exteriors. Typically, these buildings are steel or concrete frame structures, possibly with interior concrete or masonry shear walls around elevator cores and stairwells. Braced steel frame buildings of this type have a good record of earthquake performance. However, concrete frame buildings in this height range (particularly those founded on soft soil) have a fair to poor record of performance. In the 1985 Mexico City earthquake, many of the buildings that collapsed were moderate-height concrete frame buildings located on soft soil.

Businesses of the computerized banking industry in the Boston area tend to be characterized by a centralized headquarters with a network of branch offices. The branch offices are usually dispersed throughout the area, generally following the patterns of population density. The centralized headquarters tend to be located in downtown Boston.

There are no overriding operational constraints that tend to make a particular structure type more suitable for the computerized banking industry. Many banks seek to locate in modern high-rise buildings in the heart of the financial district to establish a particular corporate image. Therefore, banks are usually located in well-designed, fairly modern high-rise buildings. The lateral force design of these buildings is typically governed by wind rather than seismic loads. Nevertheless, these buildings typically benefit by having some consideration of lateral force included in their design. In moderate earthquakes, such as the earthquake postulated for this study, these buildings types have performed relatively well. Performance in a severe earthquake environment cannot be generalized because it is

frequently dictated by the details of connections and other construction features.

Most large banks have all of their critical records backed up on an off-site computer. This procedure enables a bank to recover from computer failure and other similar hazards. Such backup systems will be critical to the postearthquake recovery of the banking community. A functioning financial community is considered crucial to the earthquake recovery of the region as a whole.

Within the Boston area, large places of public assembly tend to be older structures of steel, masonry, and concrete construction. The structures typically have large, open interior spaces and are subject to very heavy loading, making them vulnerable to seismic damage. An additional consideration is that the occurrence of an earthquake could unduly alarm occupants of these facilities and lead to panic.

5.3.2 **Earthquake Damage**. As illustrated in the previous discussion, the critical industries in the Boston area occupy a variety of facilities having a wide range of seismic vulnerability. Industrial facilities within each industry will experience different earthquake scenarios and respond accordingly. A detailed study of each facility would lead to an accurate estimate of the earthquake loss; however, such results would be of little value for a general study such as this because each facility is unique. Specifically, one particular facility selected for detailed evaluation may be very resistant to earthquakes while another facility of the same commercial category may have little earthquake resistance capacity.

A relative ranking of probable earthquake damage places freight and trucking companies as the most vulnerable because damage to these types of facilities could include failure of heavy masonry walls and partial collapse of floors and roofs. Although similar patterns of damage can be expected in supermarkets and large places of public

assembly, these facilities may be somewhat newer and better maintained and sustain less damage.

A different pattern of damage is expected in high-technology facilities. Typically, building structures represent only a fraction of the total value of a facility. Frequently, the major value and major source of seismic vulnerability is the manufacturing equipment used in high technology. Experience from modest West Coast earthquakes has demonstrated that equipment can slide and topple if it is not properly anchored for seismic forces. The high-technology equipment in the Boston area is not typically installed to resist seismic forces; therefore, significant damage to these facilities may occur during the moderate shaking expected for the postulated earthquake.

Of all the critical industries in the Boston area, the banking industry is expected to suffer the least damage. The computer equipment in these facilities is considered to be the most vulnerable, especially computers located on unbraced raised access floors in upper stories of high-rise buildings. While damage to computerized banking equipment may result in a large amount of physical damage, maintenance of the previously discussed backup systems will preserve information valuable to minimizing business interruption costs.

5.3.3 **Restoration Time**. The restoration time for the high-technology industry and computerized banking facilities is expected to be the greatest of all the critical industries because the major restoration effort will be the repair and replacement of critical equipment. Other critical industries such as supermarkets, places of assembly, freight companies, and trucking companies may experience only nominal business interruption or may even be able to make temporary repairs while continuing operations.

All of the critical industries depend heavily on an infrastructure of roads, rail lines, electrical systems, water and sewer systems, and

the like. Damage to this infrastructure will undoubtedly have an impact on the restoration time for the critical industries. The impact of infrastructure damage on critical industries is difficult to judge because the population tends to adjust and adapt to deal with these circumstances. Frequently, this impact can only be judged by the impairment of commerce and economic development.

In discussing restoration time, it is also necessary to consider what resources will be available to make repairs. In the wake of a major disaster, societal resources are focused on restoring emergency and infrastructure facilities such as hospitals, police, water, sewer, gas, and electrical power. These efforts may be directed by civil authorities under state-of-emergency powers. This restoration period may last weeks or months, with restoration of the private sector a low priority during this time.

As resources become available to the private sector, industries and companies may find themselves bidding for qualified construction and repair services. Those industries and companies that can best afford to pay premium prices will naturally prevail. Companies in the high-technology industries are expected to have the necessary financial resources and the most pressing need for quick repair services.

5.3.4 **Economic Impact.** The critical industries considered in this section represent a material portion of the economy of the Boston area. Earthquake damage from the postulated earthquake will cause disruption to these industries.

The impact on high-technology industries is expected to be most severe. High-technology companies are typically in fierce competition with companies in other states, regions, and nations. An earthquake in the Boston area could cause Massachusetts companies to lose their competitive advantage and fall behind, eventually affecting the economy of the region. Significant resources dedicated to postearthquake

recovery will impede the marketing and growth potential of the Boston region. Alternatively, systematic preearthquake investments in earthquake-resistant design measures for equipment and buildings can be implemented to prevent damage from the postulated earthquake. This type of prevention is applicable to all of the critical industries.

5.4 Effects of the Season of the Year on Losses

The season of the year is a significant factor in considering the overall adverse effects of the postulated earthquake on the metropolitan Boston area. Potentially, summer and winter earthquakes would be the most damaging. An earthquake in the summer, because of the tourist trade, could adversely affect the economy of the area by diminishing tourism. However, this study is not directed toward considering this type of secondary economic effect. Rather, this study is concerned with estimating direct damage and casualties.

The earthquake scenario that would have the most serious impact on direct damage and casualties would be an earthquake occurring in the winter in conjunction with a major snowstorm. There are several reasons why this would be true.

A major snowstorm would already require the service of emergency manpower and emergency facilities. The added burden of an earthquake emergency would further tax these services, delaying emergency response and slowing recovery time. If reasonable function cannot be resumed in a minimum amount of time, further delays in return to normalcy occur. For example, a common threat to life (e.g., heart attack) may add additional casualties if emergency services are unavailable or inaccessible.

Potential for fire outbreak is also a serious consideration in this type of scenario. Unlike other seasons of the year, in winter most

residents in the study area will be using furnaces, increasing the likelihood of fire and the demand for fire-fighting aid. Snow impeding traffic and the response of fire fighters would promote more extensive fire damage.

The snow can increase fatalities associated with collapsed buildings as well. Road conditions may impede the rescue of individuals trapped inside, potentially increasing the number of deaths. Further deaths may result from individuals being exposed to freezing temperatures while awaiting rescue.

If the postulated earthquake occurred during a major snowstorm, facility functionality would also be adversely affected. Depending on the severity of the storm, the 72-hour functionality criterion of this study may be extended several days.

5.5 Conflagration Potential

It is common that fires are reported after moderate or major earthquakes. In a few cases these fires have spread in an uncontrolled manner for extended periods of time causing serious economic and life losses. Such uncontrolled fire is referred to as a conflagration. The most serious United States fire to follow an earthquake was the conflagration caused by the 1906 earthquake in San Francisco. This is the only recorded case of a conflagration in the U.S. caused by an earthquake. The other serious case of fire following an earthquake occurred in 1933, in the City of Long Beach, California, where approximately 15 fires were started.

The 1906 San Francisco earthquake led to a three-day conflagration that caused extensive fire damage. It is difficult to ascertain the actual fire damage in that earthquake. Some sources have reported that 80% of the total damage was due to fire.

The record of damage for the 1906 San Francisco earthquake, and the amount due to fire, is controversial because of the insurance situation at the time. In general, San Francisco buildings had fire insurance but no earthquake insurance. Hence, whether the damage to a building could be established to have been a consequence of ground shaking or the conflagration that followed determined whether the building would be covered by insurance. This established an overriding incentive for the City, devastated by the earthquake, to exaggerate the effect of fire. It has been reported that a fierce bidding war developed for photographs, European insurance companies seeking photographs that established that buildings were damaged by the earthquake prior to being engulfed by fire, and owners seeking photographs that showed the reverse. Current studies under way in San Francisco clearly establish that a significant number of the photographs had been altered by artists who eliminated structural damage and enhanced the flames in the photographs.[illegible]

It may be concluded from this very brief discussion of some of the insurance and financial realities of the 1906 San Francisco that the reported cost of fire damage has been perhaps exaggerated. Nevertheless, it is clear that fire damage in San Francisco was significant.

More important for this study is the casual events that led to the San Francisco conflagration of the 1906. The single most important factor here was that the earthquake severely damaged the water pipes and denied fire fighters the water to extinguish the flames. Chemical extinguishers, systems to draw salt water from the Bay for fire fighting and aerial fire fighting were not available at that time. Hence, the fires had to be allowed to continue uncontrolled in large sections of the City.

Since the 1906 earthquake, the City of San Francisco has taken many steps to prepare for containing fires after destructive earthquakes.

This has included building redundancy in fire fighting water systems, such as multiple paths to supply fire fighting water, dispersed reservoirs in neighborhoods to assure that a major pipe break will not isolate large tracts, requirements that new facilities with high occupancy have on site water storage and fire fighting systems incorporated into the facility, and most importantly, developing the capability to pump water out of San Francisco Bay for fire fighting. In the recent Loma Prieta earthquake of October 17, 1989, a fire broke out in the Marina district of San Francisco. Water pressure was lost due to breaks in the pipes, and it was the fire departments second line of defense (the ability to pump salt water out of the bay to fight the fire) which was used to control the fire and keep it from developing into a serious uncontrolled fire.

The state of the art in predicting earthquake induced fires is in its infancy. Researchers are developing methodologies- to estimate the potential for serious fires and conflagration following an earthquake. There is no widely accepted methodology at the present time. Data from previous earthquakes in the U.S. lead to the conclusion that uncontrolled fires following an earthquake are a low probability, but potentially catastrophic event. Such fires are a causal chain of events that can be interrupted whenever the chain is broken. In general, a conflagration requires that several ignitions are started as a consequence of the earthquake, that there is sufficient other fuel to feed the fire from these ignitions and that fire fighting is delayed sufficiently to allow the fire to spread to an extent that it becomes uncontrollable. High wind is a particular contributor to developing the conditions for a conflagration.

An earthquake has the potential to damage gas, oil and electrical systems, as well as appliances in buildings. Such damage can start ignitions. Damaged gas and oil lines can supply the fuel to feed these ignitions. Damaged buildings may contribute added fuel to feed these fires. Since an earthquake is an area wide event, the

potential exists that many such ignitions and fires can start simultaneously over a wide area. This coupled with damaged fire fighting systems and roads can have the combined effects of an uncontrolled fire.

In Metropolitan Boston, the study indicates that the threat of conflagration has to be taken seriously, at least in some of the cells. The following findings of the study are especially relevant here:

1) Significant parts of the study area are comprised of poor soils. The study estimates several pipe breaks in the water, gas and oil pipes in these areas. The consequences of these pipe breaks, and potential breaks in electric lines, is to produce possible ignitions and fires, as discussed above.

2) Some of these areas, such as cells 5 and 7, have a concentration of old buildings, which are expected to have significant damage, thus adding fuel to feed the fires.

3) Most of the fire stations in the study area are constructed of brick masonry, which is the most hazardous class of buildings in an earthquake. Earthquake damage to these fire stations may damage, or block access to fire fighting equipment, and personnel.

4) The study also shows that damage to highways is also greatest in these areas of poor soils.

These aspects combined, coupled with the high occupancy in these areas during weekday working hours, increases the risk of conflagration. It is disturbing to note that the City of San Francisco, with all the measures it has instituted since the 1906 earthquake to reduce the risk of fire, needed to rely on a back up

fire fighting system in the Marina district for rather moderate shaking from the Loma Prieta earthquake of October 17, 1989. This must be considered seriously in other municipalities, such as Metropolitan Boston area, which are as of yet not as well prepared to fight many simultaneous earthquake induced fires as was the City of San Francisco. There are potentially other methods to fight large urban fires, such as chemical and aerial fire fighting methods. However, we are not aware that such methods have as yet been tried on a large scale in urban settings.

5.6 Financial Loss Summary

Financial losses in connection with earthquakes arise from a number of distinct sources. Major financial losses include both direct damage to facilities and economic activity losses. This study has considered only direct damage losses.

Direct damage to facilities is typically distinguished by considering both facilities (e.g., buildings) and contents (e.g., office furniture, electronic equipment). As revealed in Chapter 4, direct damage is most commonly determined as a percentage of the replacement values of the facilities and contents involved. Major factors that affect direct damage losses are the replacement values of facilities, the severity of ground shaking, and the construction qualities of the facilities.

Table 3.1b provides some insight into the replacement values of facilities and contents in this study. The total of the values of residential, commercial, industrial, and personal property listed is $80.7 billion. These values include land value. However, the average value of a residential unit in the study area, obtained by dividing the residential values given in Table 3.1b by the number of year-round housing units given in Table 3.11a, is $77,694 and is regarded as slightly low. The range in residential unit values based on the

data in these two tables is $27,244 to $228,934. Considering the two towns involved, these values appear slightly low also. On this basis, the values in Table 3.1b are regarded as facility replacement values for this study.

A number of important facilities are not included in the values given in Table 3.1b, including (1) water and sewerage facilities, (2) public transit, (3) railroads, (4) roads (elevated highways, freeways, and streets), (5) schools (both public and private), (6) Massport, (7) government buildings (city, state, and federal), (8) military installations, (9) dams, and (10) contents (residential, commercial, and industrial). Other facilities of lesser value are also not included.

Most of the above-cited facilities have replacement values on the order of a few billion to several billion dollars. The sewerage system for the study area, for example, is estimated to be valued in excess of $4 billion. A few of the facilities mentioned above are of lesser value.

From among the items cited above that are not included in the values in Table 3.1b, contents stands out as the most significant. The value of contents varies significantly among various facilities. Residential building contents, based on fire considerations, are valued at about 70% of building replacement value. The contents of a television studio are typically valued at two to three times the replacement value of the building or space occupied. The replacement value of contents in a high-technology facility or a warehouse can readily be as high as 100 times the replacement value of the building. If such a building were to collapse or burn as result of the postulated earthquake, the loss would be on the order of 100 times the replacement value of the building.

With these considerations, we believe that the overall replacement value to be considered for the study area to be about $200 billion.

The shaking severity in connection with the postulated earthquake for the greater Boston area has been previously determined to vary between MMI V, VI, and VII, depending on the soil conditions at various locations. As previously stated in this report, however, these intensities cannot be regarded as absolute values. There are locations in the study area where the equivalent of more than MMI VIII shaking will occur, and likewise, places where the equivalent of MMI IV shaking will occur. Thus, substantial variation in ground shaking is expected for the postulated earthquake.

Construction quality in the context of this study is related primarily (if not only) to the earthquake resistance capabilities of structures in the study area. Thousands of buildings in the study area have readily survived the nonearthquake environment for more than 100 years. At issue is the earthquake resistance of typical building construction in the study area.

Wood frame buildings predominate in the study area for residential buildings. Wood frame buildings have long been recognized as being very earthquake resistant. Typical California experience has shown that for MMI VII shaking intensity, wood frame buildings experience damage in the order of 1% to 2% of replacement value.

Masonry bearing wall construction with wood floors, roofs, and interior posts is very vulnerable to earthquakes. This is a common type of construction in older (pre-1940) residential, commercial, and industrial buildings in the study area. Recent California experience with these types of buildings has revealed that (1) at MMI VIII shaking, they typically experience complete or partial collapse; (2) at MMI VII, complete collapse of buildings and curtailment of business for 72 hours or more have been commonly observed for the commercial

sector; (3) at MMI VI, damage is expected to be very modest except for very old buildings with very deteriorated mortar. Partial collapse of the older buildings is a possibility. Damage from MMI V shaking will occur, but it is expected to be insignificant.

As revealed in Chapter 4, damage factors (DFs) for a given shaking intensity vary for different engineering classifications of structures (e.g., low-rise wood frame buildings, and low-rise unreinforced masonry buildings). Specifically, the mean damage factors (MDFs) for MMI VI for low-rise wood frame and low-rise unreinforced masonry given in Table 4.5 are 4.3% and 10.2%, respectively. Although these damage factors appear high, much of the wood frame construction in the area is pre-1940 construction. Typically, these structures do not have anchor bolts connecting the wood frame to the foundation, and the older masonry bearing wall construction is very vulnerable to earthquake shaking. Many of these types of structures in the study area are located on firm ground, however, and therefore will experience little if any damage.

Finally, it is important to highlight the variabilities associated with estimating earthquake losses. As stated above, ground shaking is highly variable. The response of buildings to earthquake ground motion and the damage that results therefrom is also highly variable. The materials used in constructing buildings is important to the outcome, but the quality of the connections used in assembling the entire structure is of utmost importance. Two buildings standing side by side that have the same appearance often perform dramatically differently during an earthquake simply because of differences in the details used in connecting their components.

Considering all these factors, we estimate that the overall damage factor for the entire study area will range between 1% and 5%. This, when combined with the $200 billion value established, produces an overall direct damage loss in the range of $2 billion to $10 billion.

We expect that damage in the study area caused by the postulated earthquake is unlikely to be less than $1 billion, with a high probability of being $5 to $6 billion. This does not include potential losses due to fire.

5.7 Conclusions and Recommendations

An earthquake loss study for the Metropolitan Boston area has been performed for a 6.25 magnitude earthquake off of the coast of Cape Ann. Direct damage, casualties at various times of earthquake occurrence and functionality of emergency facilities 72 hours after the earthquake have been estimated. The methodology employed has mirrored the overall approach advanced in Reference 7. However, major modifications of the damage matrices of Reference 7 have been introduced for the first time in this study in terms of how the expert opinion collected in that study was treated to develop the California damage matrices. Also new is the methodology to correlate those California studies to Boston damage matrices. The methodology for estimating functionality is also new, even though it uses elements of the approach advanced in Reference 7. The methodology used is intended to be median centered (best estimate) values throughout the study. There has been no attempt made to evaluate the variability of these estimates in terms of a standard deviation or other statistical parameters. Qualitatively, it is recognized that there is substantial uncertainty in the results of this study. Some of this uncertainty is inherent in the nature of the problem (randomness), which cannot be reduced with further analytical studies. Other parts of the uncertainty are due to the extensive use of expert opinion, for lack of actual earthquake data, and the limitations of the level of effort available for the project. This latter part of uncertainty can be reduced with further effort, use of more rigorous probabalistic techniques and increased number of experts for the opinion data base.

In the process of conducting the study, several limitations became apparent. The first concerns the identification of the inventory data for each category reviewed. Acquiring information for facilities and resources to the level of detail requested is costly in time and money. To minimize the effort involved and to maximize the data acquisition, estimates were made in many cases because data were unavailable, inaccessible, or necessitated unreasonable cost to procure.

The same difficulties were encountered in establishing replacement values for the individual facilities within the ten categories. Understandably, the level of accuracy regarding this kind of information increases as man hours and funds increase. Therefore these two areas are not documented with precision. However, inventory and replacement values have been established with sufficient accuracy to provide results yielding a reasonably reliable understanding of the loss expected during the postulated earthquake.

The study shows that the postulated earthquake has the potential for causing significant damage to the Metropolitan Boston Area. There could be $6 billion of damage to buildings and their contents. This could be increased significantly in case of large fires in the aftermath of the earthquake. The casualty estimates are a function of the time of day the earthquake hits. There could be as many as 360 deaths, 1,400 serious injuries, 10,400 minor injuries, and some 25,600 homeless.

The study clearly shows that the severity of the earthquake damage varies both geographically and in relation to the class of facilities. Geographically, the damage is highest in the poor soil areas, such as cells 5 and 7. These cells also have a high concentration of essential facilities, such as bridges, highways, oil and gas lines, schools, hospitals and commercial high rise buildings. In terms of the class of facilities, the gross economic losses to

residences is the highest because of their large number, followed by schools. In terms of overall damage factors (ratio of damage to replacement value), schools, medical facilities, and emergency public facilities (police and fire stations) have the highest percent damage. Water and sewage utilities and dams have the lowest gross economic losses and overall damage ratio. It should be noted that in all lifelines, the service system components have not been included in the study.

Functionality 72 hours after the earthquake is lowest for school facilities, medical facilities and emergency public facilities. This is due particularly due to the preponderance of masonry construction in these classes of facilities, as well as the concentration of some of these classes of facilities (e.g. hospitals) in cells 5 and 7, which have large tracts of poor soil. The poor performance of medical facilities and emergency public facilities poses a particular problem in the post earthquake needs of the population. The poor performance of schools raises questions about the safety of the school children, if the earthquake should occur during school hours.

It is recommended that this study be used as a guide to set priorities for preparing the Metropolitan Boston area for the consequences of a damaging area. These preparations must consider emergency response plans, retrofits and strengthening of facilities and possible local code and ordinance changes. It is also recommended that site specific seismic risk studies be considered for some of the major medical facilities and public emergency facilities.

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